REFINER
AND NATURAL GASOLINE MANUFACTURER

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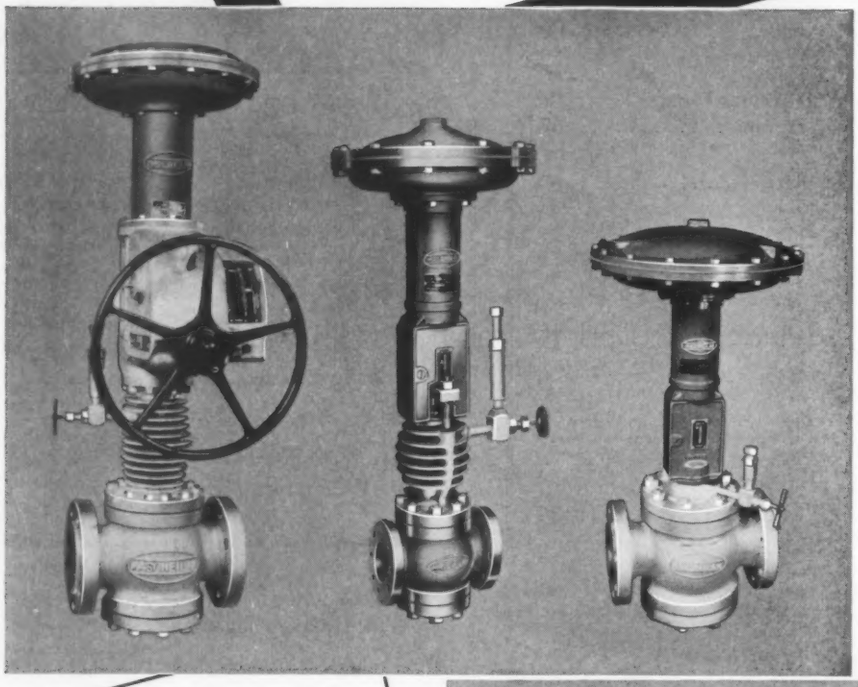

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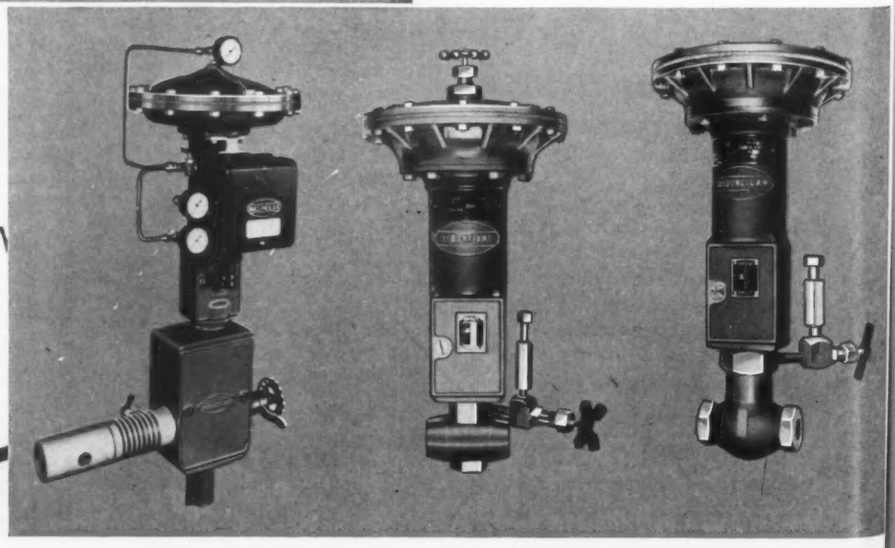


VOLUME 20, NO. 5 MAY, 1941

REFINER
AND NATURAL GASOLINE MANUFACTURER

A GULF PUBLISHING COMPANY PUBLICATION

The Look Box

AMERICAN industry must produce the most devastating war machine the world ever has known. That is its part on the program that has come to be the policy of the United States.

Chance for the Democratic Way

Whether the policy is wise or foolish is a question to be answered after this country and its allies have measured power with the totalitarian states. Experience indicates that American industry can produce the machine. In 165 years it produced more wealth than all of civilization had produced previously. That production was for peaceful pursuits. In World War I it produced armament more rapidly than any other nation could match. Given the right to retain the urge that produced the peacetime wealth, American industry can shift its objective to implements of destruction and in that outstrip all other nations.

That urge was the profit system, individual enterprise, capitalism, all of which are part of the democratic way, plus the determination to preserve the democratic way. If industry can be assured this driving force, no one need fear for lack of a war machine. It can be built and under this power it will be built.

Unfortunately there is a clash of words that is confusing. Men praise the democratic way but denounce profit, individual enterprise and capitalism. They hold out for the rights of labor but would restrict the rights of capitalism. This is inconsistent, for the two are one. The man or organization in search of a higher wage subscribes to capitalism, which is the only system that can raise wages. When men erase capitalism, the state becomes the source of wages and higher hourly rates cease. This is the record in Europe today as it has been the record of the past.

Nothing is more disheartening than to hear men plead for a preservation of democracy and follow that with a threat to "take over plants." To whatever extent plants go under the control of government the democratic way has been stifled. It is equally disheartening to hear others demand legislation that would deny labor the right to strike. To whatever extent men are denied the right to strike the democratic way has been hobbled.

These are moves toward socialism or communism. Their adoption would mean that a nation had gone totalitarian as its method of fighting totalitarian powers. The cause would be lost before a battle had been fought.

What is the democratic way? In this emergency it permits government to ask the war machine of industry. Then it permits industry to produce the machine by its own methods. Thus if the automobile industry, as an instance, can supply its part of the war machine with half the automotive plant, the other half will be left to provide automobiles for normal economy. Should the war machine demand all of the motor making plant, no cars could be built for pleasure and business.

The contrary of that is to have government demand a fixed part of existing industrial capacity without giving the industry a chance to adjust to meet two demands. It is contrary to the democratic way to have government fix prices and leave wages free. Somewhere the one will be overtaken by the other. Such moves may be legal but they are neither just nor democratic.

This is a time for having faith in democracy. What it has done is assurance of what it can do.

Natural Gasoline in National Defense

Part of the remarks of Elmer F. Schmidt, vice president, Lone Star Gasoline Company, before the twentieth annual meeting of the Natural Gasoline Association of America, Dallas, April 23, 1941.

"PRIVATE enterprise has made possible the creation of the marvelous advances of our age. It has interpreted the work of the scientists into useful achievement. A symphony of advanced living standards has fostered an intense desire for even more scientific developments and improvements over the obsolescense of yesterday's way of doing things.

"It would be impossible to calculate the valuable effects of this rapid advancement on the general intelligence of our people. We do know that we are living in a fast-moving, automatic age and enjoy benefits, comforts and pleasures that a generation ago would have seemed fantastic.

"We are all part of this realistic record of progress and achievement. The industry for which we all work has contributed much to it and is mobilized to continue to do its part in full measure in the challenging future immediately ahead.

"From the first commercial production of natural gasoline in the Sisterville field in West Virginia in 1903 and at Tidioute, Pennsylvania, in 1904 down to the present date, we can read a romantic story of progress through years of success and failure, experimentation, research, and invention. We can proudly take cognizance of the fact that in the program of national preparedness the industry is accepting its full share of the responsibility in its stride.

"We find that in 1939, 684 plants having a value of more than $90,000,000 processed over 2 trillion cubic feet of natural gas to produce more than 2 billion gallons of natural gasoline which had a value in excess of $90,000,000. With the advent of recycling plants, the statistics for 1940 will far exceed 1939.

"In excess of 141,400,000 gallons of liquefied propane and butane gases were manufactured in natural gasoline plants in the United States in 1937, 165,200,000 gallons were marketed in 1938, in 1939 this was increased to 223,600,000 gallons, and in 1940 a further increase to 300,000,000 gallons. As gases, these hydrocarbons are being delivered through mains to consumers in some 200 communities in 30 states supplying in excess of 60,000 customers for domestic purposes. Their use as fuel in industrial internal-combustion engines has grown steadily and they have proved to be an excellent fuel in heavy-duty automotive equipment and power engines. There is a widely diversified market for them in the chemical field and in the manufacture of rubber, soaps, varnishes and perfume, and we may expect expanding uses in the future. The potential liquefied petroleum gas supply is 33 times the present demand.

"The roster of new synthetic rubber materials continues to grow. Buna N, Buna S, ameripol, butyl, neoprene, thiokol, koroseal, chlorex, vinyon—these comprise only a limited roster of the success of American scientists in devising methods of utilizing home-produced raw materials to make synthetic rubber and rubber-like materials. Utilizing petroleum, natural gas, coal, limestone and air, America in 1940 appears to be approaching not only independence from foreign sources of rubber, one of its most necessary raw materials, but the assurance that whenever a declining supply, or economics require, the change-over can be made rapidly.

"Butane is an important source of butanol, explosives, lacquers, photographic supplies and is an essential ingredient in the manufacture of paint. Also it provides a very clean cut edge and has been used very efficiently for many years in the cutting of metals. Both butane and propane are currently being used as refrigerants and butane is a source of butadiene from which synthetic rubber is now being manufactured.

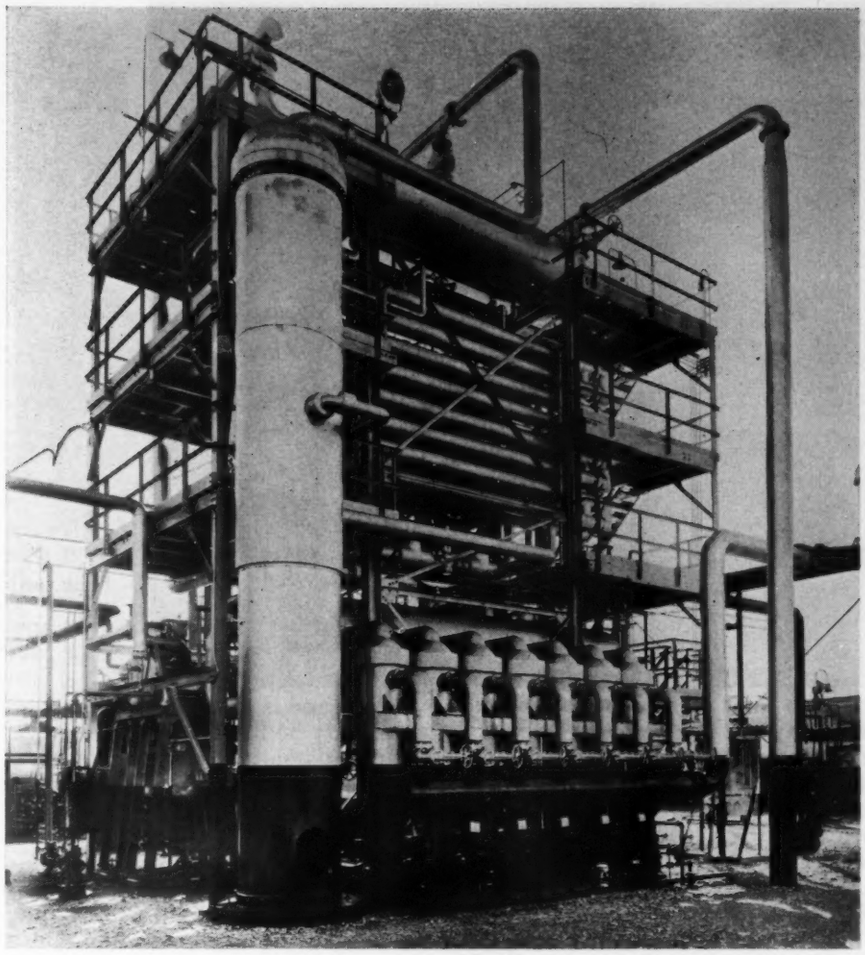
"With the advent of polymerization, alkalization and other processes which convert butane, propane and ethane into motor fuel, additional important outlets have been developed and larger volumes of high anti-knock gasoline are being made available. Recovery of these gases for use as raw material for these processes is now one of commercial actuality in the industry. They are used in blending processes, for aviation fuels and technologists forecast rapidly expanding uses in the future. These gases by the aid of oxidation, halogenation, nitration, thermal and catalytic decomposition are the foundation for an expanding chemical industry. This outstanding record has been an indication of what the industry is capable of doing under the defense emergency.

"Yes, the natural gasoline industry is an alert and expanding industry, employing in excess of 15,000 men with an annual payroll of something like $30,000,000. Most of the industry's 684 plants are far from centers of population. Their products are sold to refineries and through them reach distributing stations as an essential component part of motor fuel.

"Use of natural gasoline in processing of motor fuels is now one of the major operations of the petroleum industry. Many of the older oil fields could not continue in production were it not for the added revenue produced by the processing of the casinghead gas into natural gasoline.

"Where repressuring operations are carried on the extraction of gasoline is an important by-prod-

[*Continued on page 97*]



Ammonia absorption refrigeration system, 700-ton capacity, of the outdoor type as used in catalytic alkylation to maintain required low temperature of sulphuric acid.

Functions of Refrigeration in Petroleum Refining

W. R. McGINNIS
York Ice Machinery Corporation

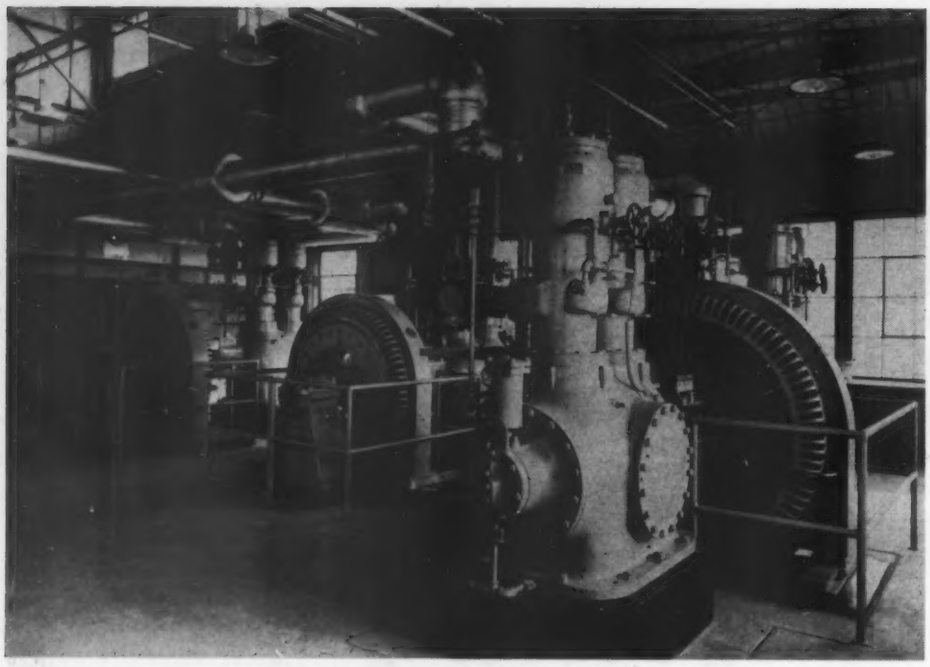
THE petroleum refiner has used mechanical cooling for many years for the purpose of removing wax from the lubricating oil; but had no other processes requiring cooling. The refinery of today, however, is an intricate chemical plant, carrying out many processing operations under careful control. Many of these operations are not possible without refrigeration—some are much improved economically by reduced temperatures, and some are in use or under development requiring very low temperatures. As a result the subject of mechanical cooling is becoming increasingly more important.

With some exceptions, refrigeration is used in the refinery to provide control of chemical reactions or to remove certain components; a large part of the original material then going to further processing at higher temperature, or to storage at atmospheric temperature. In such cases the cooled material is available to precool incoming material by heat interchange—reducing the amount direct refrigeration required.

The economic balance of heat-exchange equipment depends on the cost of producing refrigeration and the cost of exchange surface per unit of heat transferred; and these factors should be considered carefully in a determination of equipment to be installed.

With the exception of water-vapor machines, sometimes used for cooling at relatively high temperatures; refrigeration is accomplished, by evaporation of a suitable volatile liquid (or refrigerant), the vapor then being raised to higher pressure, condensed and recycled in a closed system.

A number of refrigerants are available, and may



Four vertical, reciprocating ammonia compressors in the refrigerating plant of a large West Coast acid treating plant.

be selected according to their suitability for the conditions under which they are to operate.

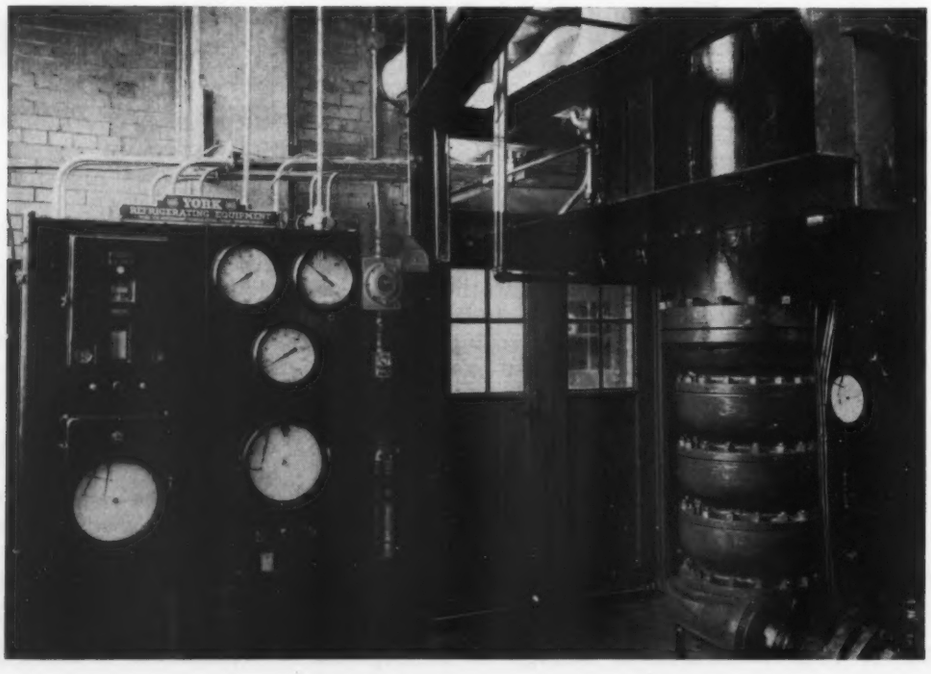
The most commonly used is anhydrous ammonia which may be used either with compression or absorption cycles. Ammonia is suitable for temperatures ranging down to -80° or -90° F. The pressures are moderate, leakage is easily detected, and fire hazard is very little. It is not a diluent for lubricating oil, therefore, lubrication of compressors is not a difficult problem. Ferrous materials are inert to ammonia, but copper-bearing alloys are subject to corrosion by ammonia.

Propane, which shows a flatter pressure-temperature curve than ammonia frequently is used. Particularly, in propane dewaxing systems it is used as a diluent and, by evaporation from the solution, as a direct refrigerant. Propane also is used in the conventional compression cycle.

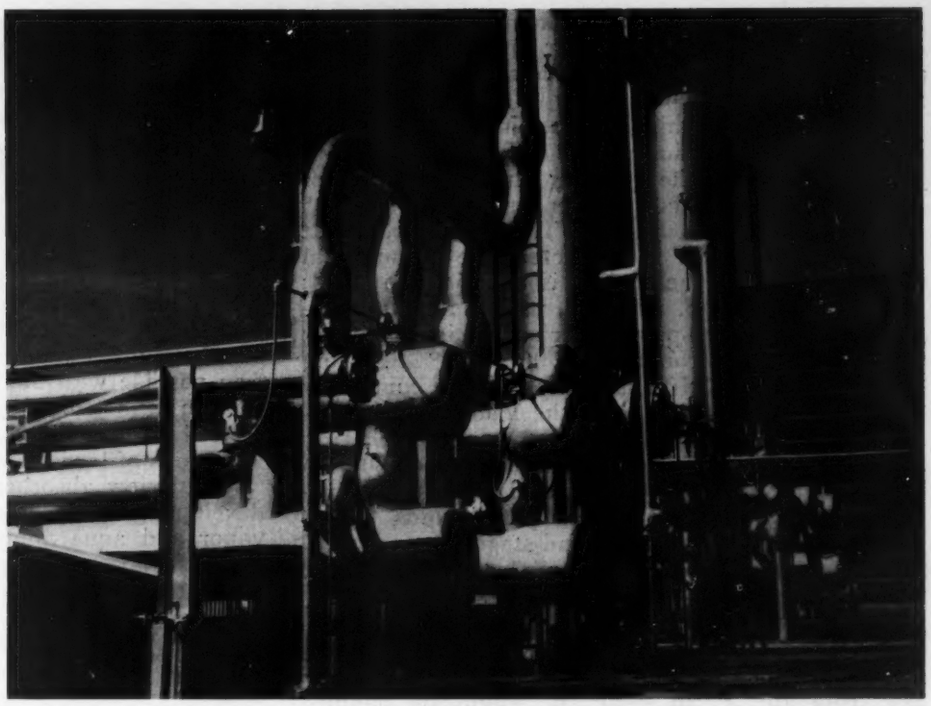
Propane is available at many refineries at low cost and may be used with any conventional construction materials suitable for pressure and temperature conditions. It has the disadvantage of being a diluent for lubricating oil, therefore, compressors usually are equipped with piston rings and rod packing of nonmetallic material. Experience indicates that adequate traps should be installed in cold-vapor lines and that vapor entering compressor should be superheated sufficiently to prevent any condensation on cylinder walls, which may occur when cold water is used in water jackets.

Carbon dioxide is used for some special processes but is not in general use. It requires equipment construction for high pressure and more power than that required for commonly used refrigerants.

Liquid sulphur dioxide is used in the Edeleanu process for solvent separation and also as a direct



Control instruments and ammonia aqua pump for 600-ton absorption refrigeration unit.



Chiller unit for reducing temperature of gas to zero F. for recovery of liquid in recycling. Temperature reduction is by expansion of gas, heat exchange with water and with ammonia vapor.

refrigerant by evaporation from the mixture. It is not ordinarily used below -20° F. In some cases where lower treating temperatures are required, an indirect refrigerating system using a suitable refrigerant is employed. Sulphur dioxide with water is corrosive to ferrous materials and, therefore, must be perfectly dry in the refrigerating system. Leakage absorbs water from the atmosphere, causing some external corrosion.

Uses for Freon

Freon 12 and Freon 11 generally are used for air conditioning applications, being non-toxic, non-corrosive and non-inflammable; but may be used for other purposes where these qualities are desirable. Freon 12 is a moderate-pressure refrigerant suitable for piston compressors and standard equipment is available in a large range of sizes. Freon 11 is a low-pressure refrigerant, particularly suitable for centrifugal compressors because of its large vapor volumes. In addition to the above refrigerants, ethane and ethylene are being used for low temperature applications. Since the critical temperatures of these refrigerants is low, they are compressed to suitable pressure and condensed by evaporation of a second refrigerant such as ammonia or propane, which in turn can be condensed by water at ordinary temperature. The secondary refrigerant evaporated in a shell-and-tube condenser by absorption of heat from the primary refrigerant then is compressed, condensed and recycled to the refrigerated primary condenser in a closed system. This is sometimes called a "cascade" system.

Power

The power required to produce refrigeration at any definite condition of evaporator and condenser temperatures is not affected to any considerable extent by the selection of refrigerant; the power being nearly the same for the commonly used refrigerants at ordinary temperatures, except CO_2 which is not frequently used.

Plants usually are constructed to use the refrigeraant directly in the chilling apparatus instead of brine circulation formerly used. Temperatures can be controlled as closely as needed by use of back-pressure valves on the chillers, maintaining necessary chiller outlet temperature.

Some special cases may require brine circulation in the chilling equipment. Calcium chloride brine ordinarily is used, but for low-temperature work the viscosity may be so high, due to density of brine required, as to seriously reduce heat transfer in the chillers; or temperature may be lower than the freezing point of this type of brine. Alcohol or hydrocarbon liquids having low freezing points and low viscosity may be used instead of brine; and are easily maintained in non-corrosive conditions.

Two-Stage Compression

Many refinery processes require product cooling to a relatively low temperature. This usually requires two-stage compression of the refrigerant gas. One compressor will boost the gas to some intermediate pressure and the second compressor will take the gas to condensing pressure.

The selection of the intermediate pressure at which such a two-stage system operates is very important. The pressure is determined in operation by the relative size of the two compressors when they are operating on a single low-temperature load and all the refrigerant gas is passing through both compressors.

The requirements of the process may restrict the temperature difference between the refrigerant and the product being cooled at the warm end of the cooling range. Thus part of the total load may be carried at a relatively high refrigerant temperature and pressure, with the remainder of the load requiring a low refrigerant pressure. In such cases a considerable reduction in compressor displacement and power will be attained by using a booster compressor setup. This consists of a two-stage system with the compressor operating on the lowest pressure discharging into the second-stage compressor at the same pressure as required for the higher-temperature load. A conventional two-stage or compound system with all the refrigerant gas from both the high- and

low-temperature load being taken into the suction of the low-pressure compressor and compressed in about equal steps will show increased displacement and power requirements.

As an example of this difference in design, consider a plant cooling a product from 35° F. to —20° F. with ammonia at -30°. The quantity and temperature of the available water fixes condensing pressure at 185 pounds per square inch gauge. The rate of cooling at higher temperatures is restricted due to material characteristics, so the cooling is done in two steps: the first from 35° F. to 10° F. with ammonia evaporating at 0° F. (15 pounds per square inch gauge); the second step from 10° F. to —20° F. using —30° F. ammonia. If this is done on the commonly used two-stage system with the loads on the low- and high-pressure cylinder about equal, all the gas will be compressed from 1.6-inch vacuum (—30° F.) to approximately 45 pounds intermediate in the low-pressure compressor, then from 45 pounds to 185 pounds condensing in the second-stage compressor.

If a booster compressor setup is properly designed for this example, the two compressors would be so proportioned to set the intermediate pressure at 15 pounds required by the high-temperature load. Then only the refrigerant gas released in cooling the product from 10° F. to —20° F. would be handled through the low-stage compressor from 1.6-inch vacuum to 15 pounds. This gas plus that from the load at 0° F. evaporator would combine to be compressed from 15 pounds to 185 pounds condensing in the second-stage compressor. With conventional compressor clearances the displacement required for this booster cycle will be 20 percent less than for the conventional two stage with equal load on the two stages. The horsepower likewise will show about 6½ percent saving in favor of the booster setup. Each example must have individual study to assure the most economical system.

Ammonia Absorption Refrigeration System

This system was used almost exclusively by the refining industry, but was superseded by compression to a considerable extent, mainly due to lack of development of the absorption plant. The old type plant required large space, had a great number of packed joints and valves, and was difficult to operate. The use of exhaust steam for low-temperature cooling made it necessary to use large amounts of water, and resulted in poor economy.

The absorption system, as newly developed during the past three years, eliminates many points of difficulty found in the older plants, and a number of plants have been installed. These units are so designed as to be automatic in operation, maintaining proper conditions in all parts in spite of changing load conditions and varying water temperatures. Both heat and cooling water requirements have been reduced, and space required is much less.

The heat input, and consequently, heat to be removed from the absorption cycle is greater than for compression. In compression the heat to be removed is that from the cooling load plus heat added by the work of compression. For absorption the ammonia is twice liquefied; first, in the absorber, where latent heat of liquefication plus heat of association of ammonia in water is released and removed; second, in the condenser, where heat of liquefication is released. The heat removed in the condenser is greater than that due to the ammonia furnished to the evaporator, as added ammonia must be furnished to condense water from vapor leaving the generator.

Improvements in Absorption

Some of the improvements to the absorption systems, resulting in better economy and ease of operations are:

First, by use of adequate heat exchange the weak aqua cooler is eliminated, and the heat formerly removed here retain in the system thereby reducing the amount of primary heat required.

Second, by the use of a bubble column for rectification the heat removed from the cycle is further reduced and lower water content of the ammonia secured than possible with the old rectifier. The reflux to the column is instrumentally controlled so as to secure desired rectification substantially independent of variations of load or temperature of cooling water.

Third, new absorbers of compact type have been developed, affording effective contact of ammonia vapor and aqua ammonia with very little friction loss, and no static head loss, so produce solution of concentration, substantially that due to pressure and temperature existing. The flow of weak aqua to the absorber is instrumentally controlled to the amount required to absorb the vapor from the evaporator, thereby controlling the absorber pressure.

Instrumental control of all functions enable these units to maintain correct operating conditions with manual adjustment for seasonal changes only.

Efficiency has been much improved by elimination of unnecessary heat removal from the cycle. Thermal efficiency at —30° F. evaporator temperature and 100° F. condenser temperature is about 33 percent, and at +30° F. evaporator about 50 percent. Also water required is less than for the old type plant.

These units are now built as outdoor plants requiring no building except to house control instruments. Single units of 1000 tons capacity are in use and much larger are practical. Absorption refrigeration especially is applicable to the refining industry; as in many cases hot vapors are to be condensed or liquid to be cooled, requiring water for cooling. This heat may be used in the generator of an absorption system to produce refrigeration for condensation of light vaports, or for removal of process heat; securing refrigeration at no expense for primary heat.

In nearly all cases the maximum temperature of cooling water prevails for only a small portion of the year. Since it is necessary to design the plant for maximum conditions, temperature differences should be kept large by use of sufficiently high steam pressure for summer conditions. The lower water temperatures will rapidly reduce the steam pressure required.

Compression Systems

New types of equipment have been developed for a wide range of capacities and for various refrigerants. One is the centrifugal compressor used for Freon-11 and Freon-12 for large capacity units, which are in general use for higher-temperature levels, but may be used for low-temperature work where large units are required. Another recent development is the semi-radial "V-W" compressor. This has the inherent balance of a radial engine and by placing all cylinders above the center line, the shaft center is lowered and all cylinders are easily accessible. These machines, being well balanced, may be mounted in a process structure close to the point of refrigeration.

Useful Products From Natural Gas

FRANK H. DOTTERWEICH
Texas College of Arts and Industries

GROWTH of the natural gasoline industry has made available increased amounts of by-product natural gas which has been marketed as a fuel and source of energy and more recently as a chemical raw material from which many useful products may be manufactured. These useful products include; synthetic rubber, plastics, 100-plus octane fuel, and many chemical raw materials essential in modern industry. These products which may be produced from natural gas may play an important role in the future development of our country, in that, they may be used in the construction of equipment for the armed forces, and they may be used in consumer products to replace strategic metals necessary in other fields. The amount of these essential raw materials supplied by the natural gasoline and natural gas industries will depend upon the ability of the groups to recover and supply these raw materials and to maintain and actively support research work to insure the use of natural gas for useful products of today and tomorrow.

The paper was presented before the twentieth annual meeting of the Natural Gasoline Association of America, Dallas, April 23, 1941.

GROWTH of the petroleum industry is being accompanied by rapid expansion of one of its most important segments, the natural-gasoline division. Growth of the natural-gasoline industry, in turn, has made available increased amounts of by-product natural gas which has been marketed as a fuel and source of energy and more recently as a chemical raw material and reactive agent. The phenomenal expansion of modern industry led by the developments in synthetic rubber and plastics may be attributed to rigorous research and the enormous supply of inexpensive organic chemical raw materials, chief of which may become natural gas. Should by-products of today develop the industries of tomorrow, natural gas may play an important role in the rapidly changing industrial world. It is of extreme importance to the natural-gasoline industry, with large volumes of by-product natural gas, to be aware of the potentialities of this raw material. The author will endeavor in this paper to present some of the many useful products which may be manufactured from natural gas.

Natural gas as produced is a mixture of hydrocarbon and non-hydrocarbon gases. The hydrocarbon gases may include methane to heptane and the non-hydrocarbon gases, carbon dioxide, helium, nitrogen, and hydrogen sulfide. These gases can be separated, by modern methods of extraction and fractional distillation, into the fololwing groups: dry gas, liquefied gas, and natural gasoline.

Natural gasoline may contain the hydrocarbons of isobutane through to the heptanes. The use of this product as a source of fuel is well known. Dry gas consisting of methane to propane and liquefied gas of propane to butane are the products by which the firm foundation of the natural-gas and bottle-gas industry, respectively, have been founded.

Dry natural gas and more recently bottled gas have been used as a fuel and source of energy and their expanding use in these fields should be accelerated by the recent development of the combustion gas turbine.[1] In addition, Servel's all-year gas-operated air conditioner and the modern gas-operated refrigerator are examples of the many domestic and industrial duties this perfect fuel may perform. In addition to its energy use, dry natural gas and bottle gas combined with the non-hydrocarbon group may be used as raw materials for the production of synthetic organic chemicals from which many useful products may be manufactured.

Non-Hydrocarbon Constituents

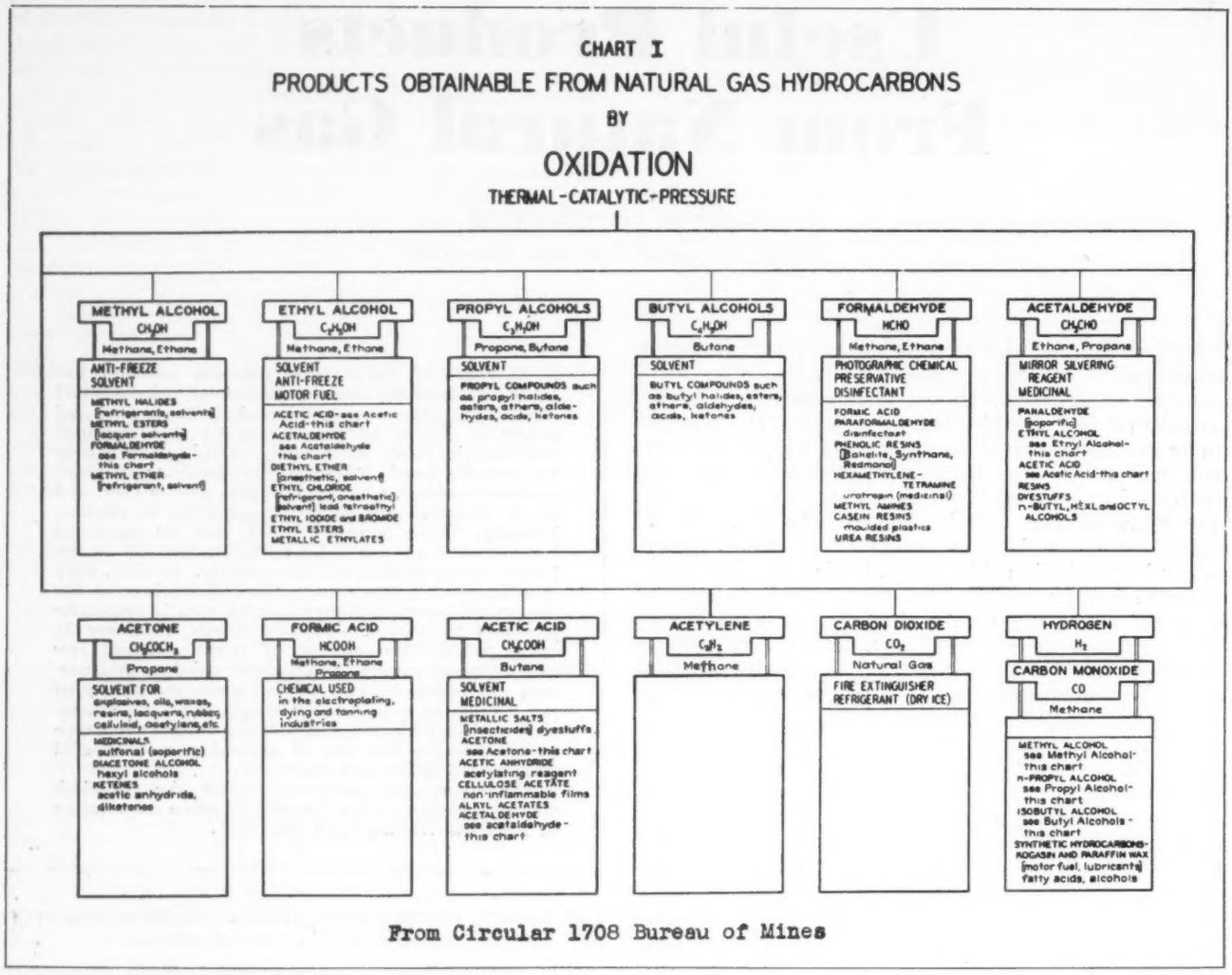
It is very difficult to report the many chemical products which may be manufactured from natural gases in that the industry is developing so rapidly. For a very thorough and up to date discussion of these products reference is made to the work of Smith[2] who has presented this information in a very satisfactory manner by the use of charts.

The non-hydrocarbon constituents, with the exception of carbon dioxide, are found in natural gas in relatively small amounts. Hydrogen sulphide, which is objectionable due in part to its corrosive nature, may be removed and marketed for agricultural uses. The extremely fine state in which the sulphur is recovered has special value both in liquid sprays and as a solid dusting material. Helium, although present in natural gas in small amounts, is nevertheless of great value, as an oxygen diluent for medical purposes, inflation of lighter-than-air balloons and ships, as a preservative, and in the electric industry. Some wells produce carbon dioxide in relatively large amounts and make possible its recovery and use as a refrigerant, fire extinguisher, food preservative and beverage carbonator.

The hydrocarbon groups of dry natural gas and bottle gas which are by-products of the natural gasoline industry must be converted into other products before they may be used to manufacture useful products. There are four methods of conversion: decomposition, oxidation, halogenation and nitration.

Decomposition consists of splitting the hydrocarbon by thermal, catalytic and electric means. Processing natural gas by this method yields many synthetic raw materials which may be used in the production of many products, chief of which are plastics, synthetic rubber, motor fuel, explosives, dyestuffs and hydrogenated vegetable and mineral oils.

Chart 1, reported by Smith,[2] gives some of the chemical products produced by oxidation. Oxidation



From Circular 1708 Bureau of Mines

CHART 1

may be defined as the introduction of oxygen into the hydrocarbon molecule by the aid of heat and catalysts. This method insures the production of many alcohols, aldehydes, ketones and ethers which are the chemical raw materials of many modern products.

Halogenation consists of the reaction of the hydrocarbon molecule with a member of the halogen family, this reaction being activiated by heat, catalysts, and light. The many chemical products formed by this process are useful as refrigerants, solvents, medicine, insecticide, fire extinguishers, and floatation agents. Chief of these useful products could be tetraethyl lead; vinyl chloride and vinyl acetate for the manufacture of plastics and sodium polysulfide which is used in the manufacture of a rubber substitute.

Nitration defines the method by which hydrocarbon gases and nitric acid in the vapor phase are allowed to react and by the aid of heat a series of nitro-compounds[3] are formed, such as nitromethane, nitroethane, nitropropane and nitrobutane. These compounds find use as organic reagents and recently as raw material for explosives. Nitromethane reacts with formaldehyde to form a product that when acted on by nitric acid produces an explosive, nitroisobutylglycerine trinitrate. This compound is reported to be more stable than TNT, and the future of this explosive appears to be very promising. The many products which may be manufactured from these nitro-compounds are varied, such as: rubber accelerators, chloropicrin and plastics. Commercial Solvents Corporation has started commercial production of these nitro-paraffins in addition to a long list of their derivatives. The development of the nitro compounds has just started and it is predicted[4] that these agents will create a new and dynamic branch of industrial and organic chemistry.

As previously stated and reported[2] many raw materials may be obtained by the decomposition or cracking of natural gas, included under this classification is the method of dehydrogenation. Methane, a major constituent of natural gas can be cracked to give unsaturated gases and aromatic liquids, but at present the methods available are extremely difficult and inefficient. Under these conditions, methane is at present used as a major raw material to produce hydrogen for hydrogenation purposes and in the manufacture of carbon as a pigment in ink, paint,, and as a filler in compounding rubber. Ethane and the heavier hydrocarbons, however, produce many olefine hydrocarbons on being cracked. It is reported[4] that one chemical company is producing from these olefines more than 100 products, including 24 different kinds of alcohols, 4 ketones, 23 esters, 13 amines, and 35 other chemicals.

The dehydrogenation and polymerization of natural gas is now being used by oil companies throughout the country to produce super anti-knock gaso-

lines. Recent advances in this field is the announcement of neohexane, a new synthetic hydrocarbon manufactured by thermal alkylation of isobutane and ethylene. Phillips Petroleum Company[5] has announced this new product which has now outgrown its pilot plant and is in commercial production at Borger, Texas. This fuel has an octane rating of only 94, however, its high lead susceptability and high volatility make possible the production of fuels with 115-octane rating. This 100-octane plus fuel dictates better engine performance and economical operation for long-distance flying. However, the potentialities of this new fuel will not be known until higher compression engines are available. This development is merely the introduction of things to come, in that this fuel may soon be made by catalytic methods, which in turn may introduce fuels with higher octane ratings. Thus a new chapter in aviation fuel production may be made possible by the large volumes of an inexpensive raw material.

During the past two years much has been heard relative to Buna rubber in Germany, Italy and Russia. Present day conditions, reflecting possible decreases in import rubber supply, have centered interest on synthetic rubber and its raw materials here in the United States.

The basic raw material for Buna type rubbers is butadiene. This diolefin is made in Geramny by a synthetic process using acetylene obtained from carbide as a raw material. Italy produces butadiene from alcohol. Although these raw materials are available in the United States, the major production of synthetic rubber apparently will be from natural and refinery gases.

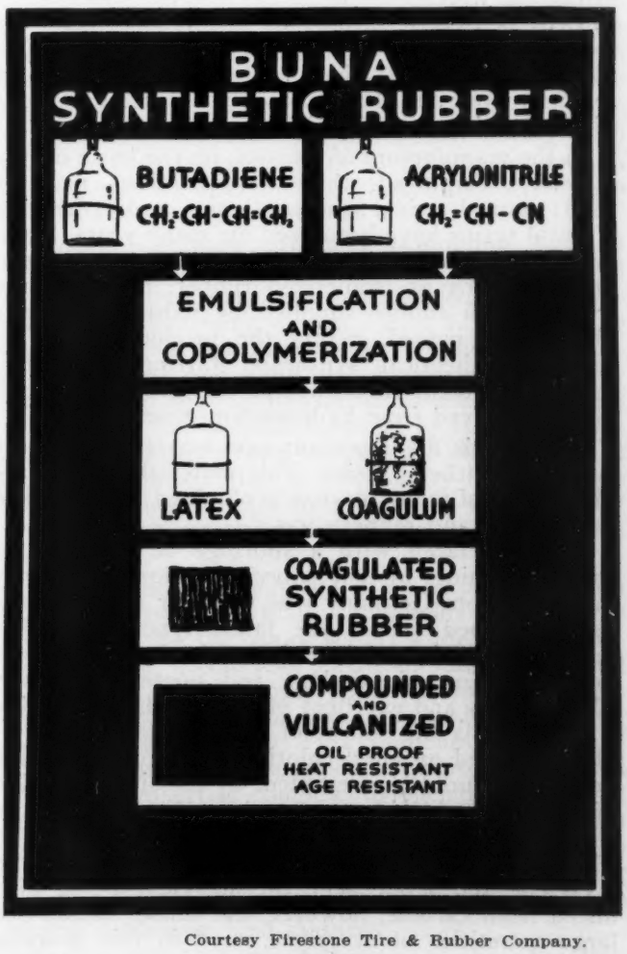
In addition to butadiene the other raw material required in the production of Buna type (Perbunan) rubbers is acrylonitrile, Chart 2. This material is in commercial production by the Carbide and Carbon Chemicals Corporation[6] and it is understood that Dow Chemical Company will soon start production on this material. Production of this type of rubber is now being carried on by Standard Oil Company of Louisiana at Baton Rouge and Firestone Tire & Rubber Company at Akron, Ohio.

Of the various types of Buna rubbers produced it has been reported[7] that only two are being considered by Firestone. Buna N, or Perbunan, will go into immediate production at Akron, Ohio. This product will not compete with natural rubber due to its cost being two to four times greater. Instead new markets will be created where Buna's high resistance to swelling and deterioration when in contact with oil or gasoline, makes it ideal for gaskets, hose and other industrial applications. In addition, its excellent insulation qualities and superior resistance to abrasion make it highly practical in many fields. Of the materials used in Perbunan rubber approximately 80 percent is butadiene. Acrylonitrile, produced from coal tar, is added. In the production of Buna S, the same proportion of butadiene is mixed with styrene. Buna S, used abroad in automobile tires, possibly will play a minor role in tire production in the United States because of its production cost.

Goodyear Tire & Rubber Company has announced Chemigum, a butadiene polymer to be in semi-commercial production. Latest reports are that the new plant will soon be in operation at Akron, Ohio. Standard Oil Development Company has recently announced a new product, Butyl rubber, consisting of polymerized butadiene and butene.

Hydrocarbon Chemical and Rubber Company, sponsored by B. F. Goodrich Company and Phillips Petroleum Company, is producing a butadiene synthetic under the name Hycar. Hycar is a synthetic rubber produced by polymerization of butadiene. This product was developed to fulfill the demands for flexible articles resistant to oils, fats and aliphatic hydrocarbons, heat and oxidation. In addition it is reported[6] that B. F. Goodrich Company has constructed a plant at Niagara Falls to produce Koroseal, a plasticized polyvinyl chloride. This compound covers a wide range of uses, including insulation for electric wires, chemical- and oil-resistant hose, wrapping material, and fabric coating.

The newer type of synthetic rubbers all require butadiene and production of this compound is rapidly



Courtesy Firestone Tire & Rubber Company.

CHART 2

increasing. In addition to the source of production previously mentioned, the following companies are entering the field or increasing their production rate, Dow Chemical Company, Shell Development Company, and the Carbide and Carbon Chemicals Corporation.

Neoprene, an entirely new engineering material, is being produced by E. I. du Pont de Nemours & Company. This product cannot be called synthetic rubber because it is different in chemical composition and cannot be correctly termed a rubber substitute because it has physical properties that make it superior to rubber under certain conditions. Neoprene is being used by rubber manufacturers to replace many other materials in service where its superior properties, such as resistance to many chemicals, heat, sunlight, and oil make its use desirable. This compound has not only replaced rubber in many cases, but may also be satisfactorily used as a substitute for leather, waxes, metals, fabrics and other compounds.

This new product, chloroprene rubber, is now being manufactured from the following raw materials: coal, limestone, and salt. The coal and limestone produce calcium carbide from which acetylene is obtained. By means of catalyst the acetylene is converted into monovinylacetylene, this being treated with hydrochloric acid, made from salt, produces chloroprene which is then polymerized to form Neoprene. Here again we have a new product of great potentialities manufactured from acetylene, which in turn, may be produced from natural gas.

The rapid development of the plastic industry is attracting widespread attention and this astonishing growth is clearly verified by the report[8] that this industry has increased 36 fold since 1922. This phenomenal growth has been made possible by research work and the availability of large quantities of inexpensive raw materials.

In the manufacture of plastics, on the basis of raw materials employed, three classifications may be used: natural resins, semi-synthetics, and synthetics. Natural resins have been used for many years. Semi-synthetics defines the group of high-molecular-weight products such as isomerized rubber, manufactured from natural rubber supplied by nature. Synthetic plastics, as named, covers the products manufactured by chemical synthesis starting with low-molecular-weight chemicals. In this group are found plastics derived from hydrocarbon gases.

Ethylene is an important raw material for many types of synthetic resins. This material used in the production of many plastics is obtained from cracked natural gas and refinery gas.

England, faced with a shortage of material for cable sheathing, in that polyvinyl chloride formerly imported from Germany was used for this purpose, has developed one of the latest type of plastics, polythene. This product is made by the direct polymerization of ethylene and possesses rubber-like qualities and excellent insulating characteristics.

Ethylene is the source of an important group of plastics based on vinyl chloride. Vinyl chloride may be manufactured from ethylene by the direct addition of hydrogen chloride to acetylene. In addition and closely related to ethylene chloride is vinyl acetate. This compound is now chiefly manufactured from acetylene and acetic acid, the acetylene being produced from carbide, however, the future should see large quantities of acetylene, used in this process, produced from natural gas. These compounds, together with polyvinyl butyral, are being marketed and sold in varying proportions under the name of vinylite resins, a product of Carbide and Carbon Chemicals Corporation.

Vinyl chloride may be polymerized and then plastized to form a commercial product, Koroseal, previously mentioned. This product of industrial and commercial use replaces rubber for applications dictating resistance to sunlight, acids and where good flexing and aging characteristics are required.

Vinyl acetate may be polymerized to a product called polyvinyl acetate possessing unique adhesive properties, such as "vinly seal," a thermoplastic type of adhesive, an excellent binding agent for artificial wood. Vinyl chloride and vinyl acetate may be mixed in varying proportions and polymerized together to give products of widely different commercial uses. When a product is obtained by using 85 percent chloride and 15 percent acetate an injection molding powder may be obtained. An example of such a related compound is series V of vinylite resins. This resin may be obtained in the form of injection molding and compression molding plastics, vinylite coated paper, rods and tubes, and as base resins for surface coating formulations. An interesting application[8] of this series of resins, is the so-called "Keglined" beer cans.

The most amazing development in this new field of resins is the entrance into the textile field. When the percentage of vinyl chloride is 90 percent and mixed with vinyl acetate and then polymerized to give a compound with a molecular weight of about 20,000, a new substance, vinyon, is formed. This product has unique film and filament forming properties making possible the production of vinyon filter cloth, bathing suits and other textile products. The unusual properties of vinyon have been listed,[9] and some of the outstanding ones are: it will not support combustion, bacteria or fungi growth, and it is highly resistant to many organic and inorganic chemicals. A special procedure by which vinyon may be satisfactorily dyed has been perfected and adds to the usefulness and desirability of this product. Vinyon may be produced from two raw materials, natural gas and salt.

Vinyl compounds are also available in the heavier form such as polyvinyl butyral, four carbon atoms. This compound is marketed under the name of vinylite resins, series X. This compound is of extreme value in the manufacture of newest type safety glass because of its great strength and toughness, particularly at low temperatures. This new product has within the period of two years replaced cellulose acetate in almost all the safety glass that is used in automobiles.

In synthetic resins, the acrylics are outstanding by their outstanding colorless transparency, chemical resistance, and stability against aging and weathering. This product is manufactured by complicated chemical synthesis, Chart 3, from raw materials such as natural gas or petroleum, salt, air and water. These resins range in consistency from soft, tacky, semi-liquids to hard, tough, thermoplastic solids. These variations are produced by controlling manufacturing conditions rather than by substitution or addition of plasticizers which in turn may produce taste, odor, instability or flaws in the product. The crystal clarity of these resins is made possible by

purity of raw materials, cleanliness in equipment, and satisfactory manufacturing procedures.

These acrylics are available in many forms, an unusual combination of properties dictate their use in many fields. In aqueous emulsions and solutions in organic solvents, they find use as flexible, permanent finish for textiles and leather; as adhesives, and as a laminating layer for safety glass. Under the trade name Crystalite, these resins are used as a molding powder to manufacture industrial and decorative parts.

One of the most interesting and important applications of these resins is their use as Plexiglas. This product is one of the hardest acrylic resins, a colorless, transparent, thermoplastic solid. In addition it may be obtained in a number of colors, both transparent and translucent, varying from delicate tints to the deep shades. The thermoplastic property of Plexiglas make possible its fabrication at ordinary temperatures attained in ordinary ovens. By the use of wood tools it may be readily machined.

The optical properties of Plexiglas are of extreme interest in that it is more transparent than optical glass, transmitting every color of the spectrum fully, and its light transmission of 92 percent, relative to 88 percent for good glass, make it difficult to photograph and often invisible. In addition it is transparent to ultra-violet rays down to 300 millimicron, with 90 percent efficiency and also transmits infra-red and X rays. These exceptional properties of Plexiglas promote its use as medical instruments. Optometrists make use of these unique properties to produce Plexiglas contact lenses to be worn by sportsmen and actors and others who wish to avoid wearing glasses. The contact lenses are made to fit the eyeball and then ground to give the proper corrective curvature and it has been reported that these lenses may be used without toxic effect to the eye.

The excellent insulating properties of Plexiglas make it desirable in electrical applications where high dielectric strength is required. Lamps and lighting fixtures may be produced and used with a greater degree of safety.

The light weight, high impact strength and permanent colorless transparency of Plexiglas is used to advantage in the production of aircraft parts. These excellent properties of Plexiglas allow it to be used in the form of transparent curved sections of the plane, as windows and windshields, as well as cockpit enclosures, gun turrents, and landing-light covers. Plexiglas products are now standard equipment on all types of military, transport and private planes.

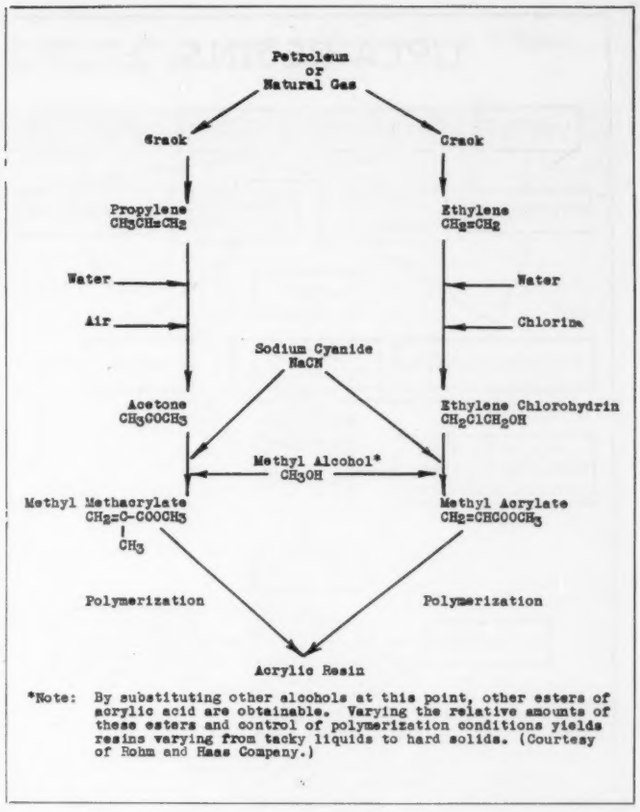


CHART 3

Plexiglas, combining the transparency of glass with the strength of a synthetic plastic should be of ever-increasing use as products of commercial, scientific and industrial applications.

Urea resins increased in production during 1940 over the previous year. This increase in production in part may be attributed to their introduction into the field of baking enamels in 1937.

Plaskon Company produces a molding material under the trade name of "Plaskon." This material is manufactured from urea, formaldehyde, filler, pigment and plasticizing agents, Chart 4. It should be noted that the formaldehyde is obtained from carbon monoxide and hydrogen. However, it is commonly stated that in Russia formaldehyde is being produced in considerable amounts by controlled oxidation of methane from natural gas. In addition it has been reported[7] that in this country formaldehyde is being produced as a by-product in a process for removal of oxygen from natural gas in transmission operations.

Plaskon molding material is an improvement on the dark browns and black compounds available for many years. By the use of water, white urea formaldehyde resin, a colorless plastic molding compound is produced and by proper pigmentation this can be converted into any color from pure white to varying shades entirely lightfast. This compound being available in many colors together with its exceptional electrical properties combine to open new fields of application for which thermosetting plastics had been heretofore unsatisfactory. Plaskon may be used in many ways, chief of which are its application for lighting fixtures, buttons, housings, display containers, tableware, and closures.

The most widely used resins are the phenolics.

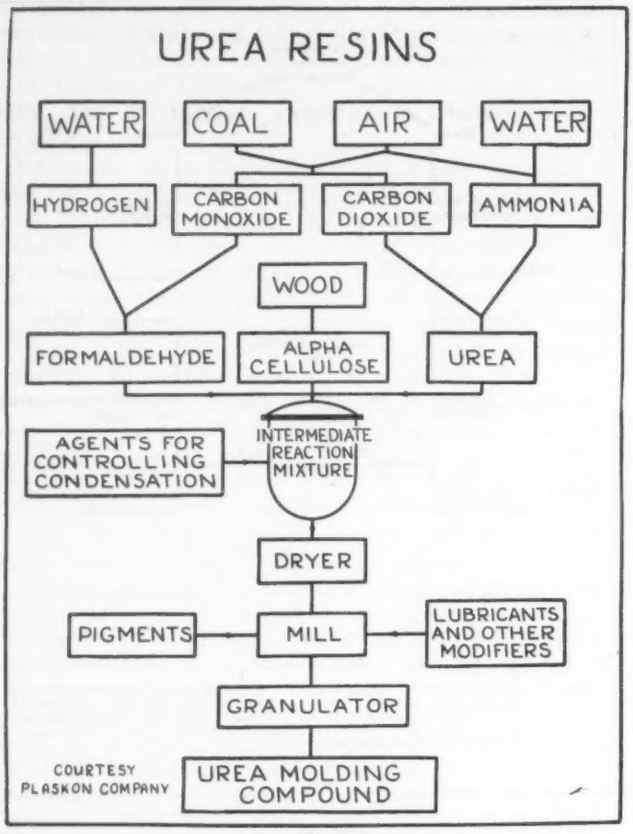


CHART 4

Typical examples of these resins are bakelite, opalon, and resinox phenolic compounds. On the basis of tonnage produced, these phenolics have always been the most important synthetic resins. These resins may be produced by the reaction of the phenols with an aldehyde, such as formaldehyde, in the presence of a catalyst. At the present time only a small amount of phenols are used in the synthesis or resins for protective coatings. Yet it is interesting to note that the side chains of these phenols are obtained with such raw materials as isobutylene and trimethylethylene from refinery and natural gases. Uses of these resins include high- and low-frequency radio insulating parts, clock crystals, aircraft instrument panels, dishes and many other applications, such as engineering applications in the field of binding agents and cement.

Development in the plastic industry is continuous and of the new-comers vinylidene chloride and melamine resins are outstanding. Vinylidene chloride has recently been announced by Dow Chemical Company and in addition to posessing many desirable features of the plastic group, it has an extremely high tensile strength. This product is being successfully used in women's wear items such as felt hats and dress trimmings. Its use as lines in commercial and sport fishing has been most satisfactory. Melamine resins which are made by reacting melamine with formaldehyde. These resins replace urea resins where better molding properties and water resistance are required.

Many useful products which may be manufactured with natural gas as a raw material have not been mentioned in this paper. The many possible products as given, however, indicates the tremendous potentialities of natural gas as a raw material. The best insurance to recover these important raw materials and make them available to industry is active research work.

In response to the vital and immediate need for fundamental research felt by the gas industry of the United States, a special committee of the American Gas Association, formed about two years ago under the leadership of Frank C. Smith of Houston, conducted a study and made a report to the association on the subject, recommending the establishment of a research institute by the industry. The same committee, upon the discharge of its duties, constituted itself a group which continued its studies of the means by which research could best be accomplished in behalf of the gas industry and, after a great deal of study and investigation, drafted a plan for the establishment of an institution to be called the "Institute of Gas Technology." This plan is now under consideration by member companies of the gas industry and may become realized within the present year. It is significant to note that the organization finds throughout the gas industry a general realization of the need for research, both fundamental and applied, and has received encouragement and pledges of support from substantial elements of the gas industry.

The many useful products some of which were discussed in this paper may play an important role in the future development of our country. They may be used in the construction of equipment for the armed forces of our country and they may be used in consumer products to replace strategic metals necessary in other fields. The amount of these essential raw materials supplied by the natural gasoline and natural gas industries will depend upon the ability of the groups to recover and supply these raw materials and to maintain and actively support research work to insure the use of natural gas for useful products of today and tomorrow.

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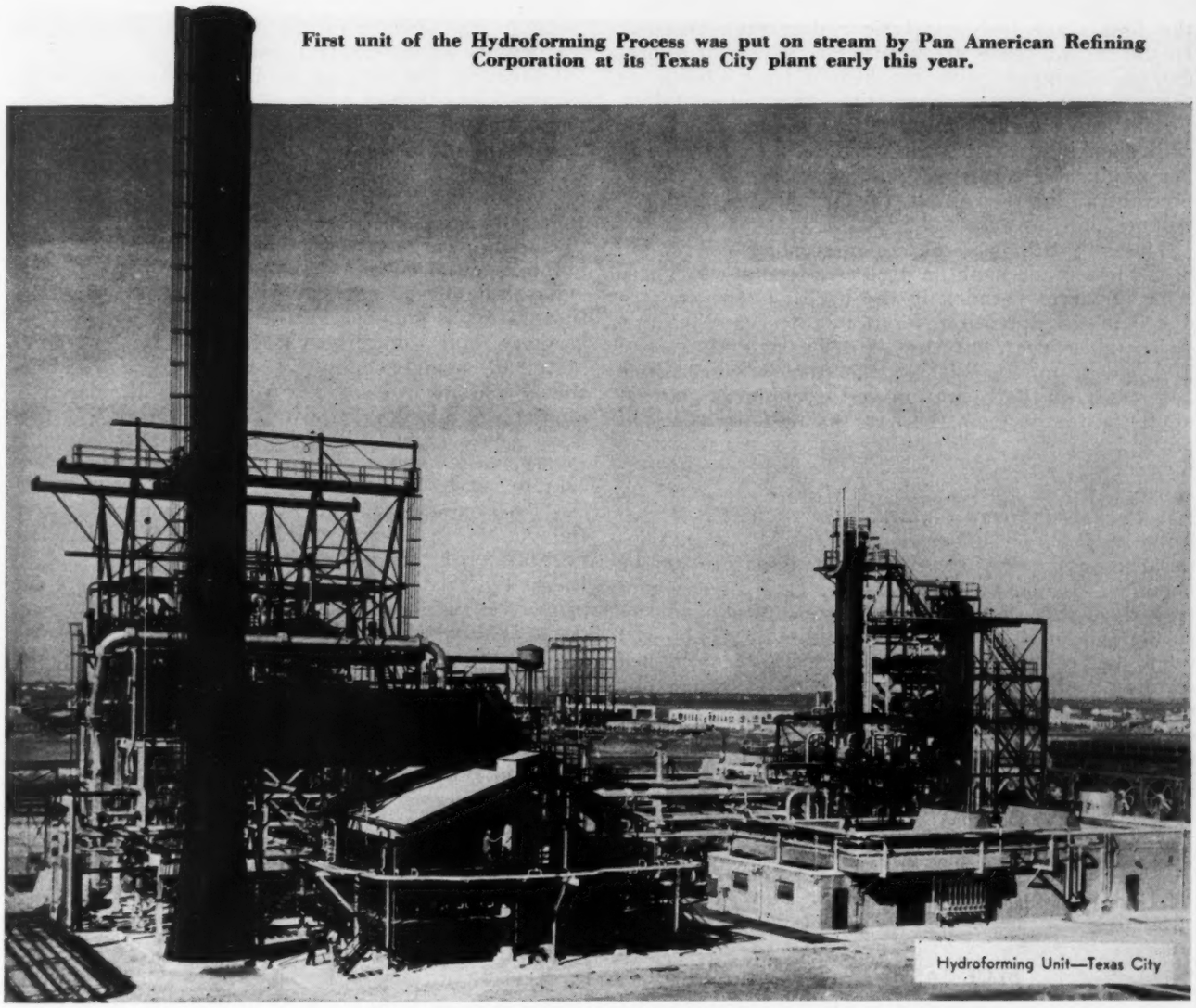
In the preparation of this paper much of the information used was supplied by companies using natural gas or related raw materials in the production of their products. The response to this solicitation was highly satisfactory and the author wishes to acknowledge this splendid cooperation. In addition he wishes to particularly acknowledge the contributions to this paper by Dr. Harold M. Smith of the Bureau of Mines, Frank C. Smith of the Houston Natural Gas Corporation, E. Holly Poe, and C. George Segeler of the American Gas Association.

First unit of the Hydroforming Process was put on stream by Pan American Refining Corporation at its Texas City plant early this year.



First Hydroformer Unit Put on Stream

J. V. HIGHTOWER

A NOTABLE contribution to oil-refinery engineering and motor-fuel production is the new 7500-barrel-per-day hydroforming unit operating in the Texas City, Texas, plant of Pan American Refining Corporation. The unit is the first commercial installation of its type. It embraces a catalytic process for the conversion of low-octane naphtha into 77-80 C.F.R.-M. octane aromatic gasoline, containing a relatively small percentage of unsaturates. This gasoline is being run directly into finished motor fuel without prior treatment.

The installation is a development carried out by several companies, primarily The M. W. Kellogg Company, Standard Oil Development Company and Standard Oil Company (Indiana). Design of the Texas City unit was worked out by engineers of The M. W. Kellogg Company in collaboration with engineers of Pan American Refining Corporation and Standard Oil Company (Indiana). The unit is operated under licenses from Standard Catalytic Company.

The process differs from thermal reforming. In

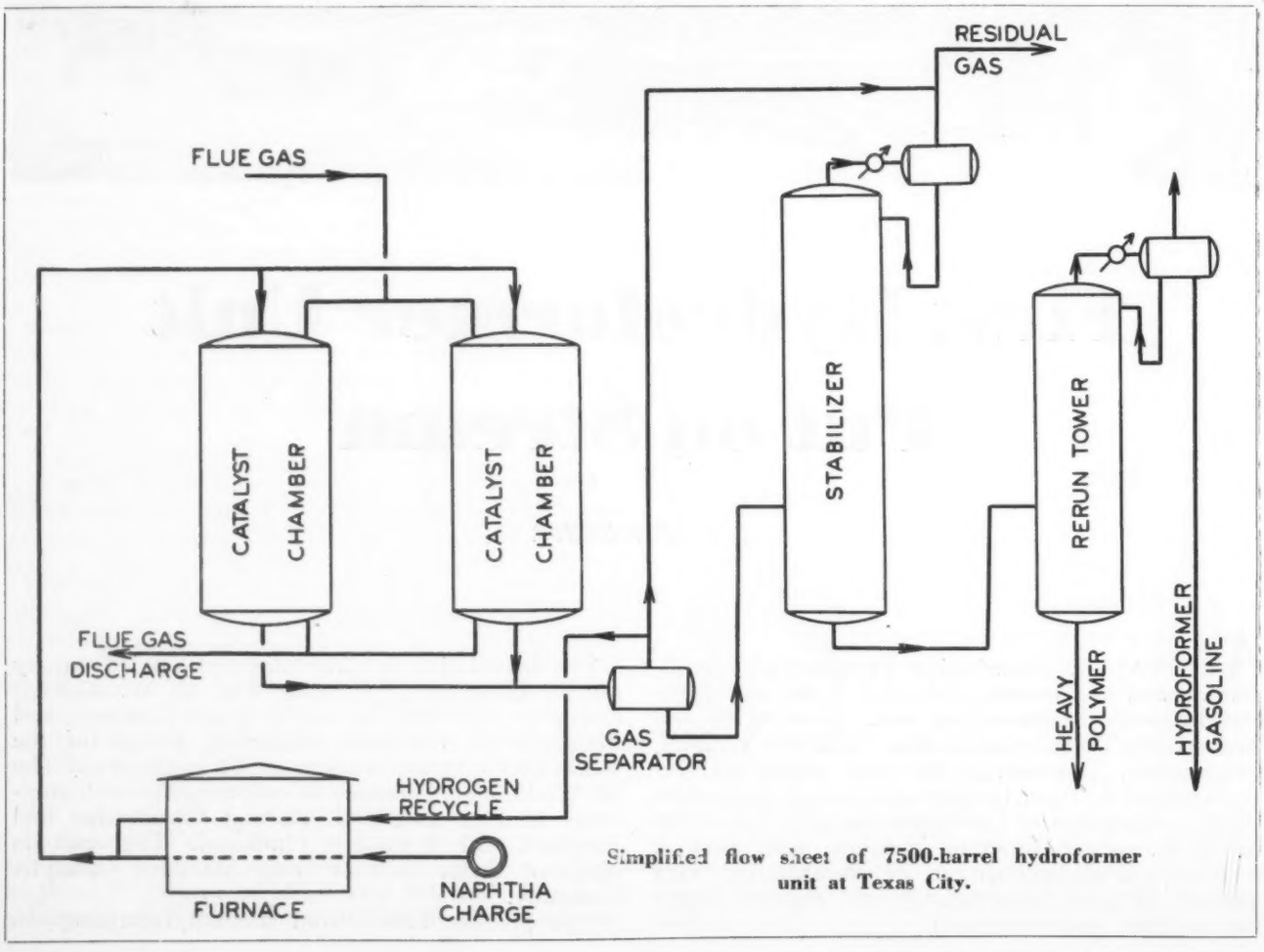
the first place it is catalytic rather than thermal. In the second place it involves circulation of hydrogen in admixture with the heated fresh charge as the mixture passes over the granular catalyst. Finally, the gasoline produced is less olefinic, chemically speaking, than gasoline of the same octane number produced by thermal reforming, and has an appreciably higher content of aromatics—45 to 50 volume percent.

The unit brings about an interesting conversion of the low-grade naphtha used as a feed stock. There is an apparent paradox in the use of hydrogen produced in the operation, for it might seem that this gas would cause the process to be essentially one of hydrogenation. Such is not the case, however. The net result of the operation is to remove a portion of the hydrogen from the naphtha feed. As the feed passes over the catalyst after leaving a preheating furnace the catalyst causes a chemical change resulting in the splitting off of hydrogen atoms. By introducing a given quantity of recycled hydrogen into the chamber under definite conditions of temperature and pressure, the rate and nature of the chemical change produced by the catalyst are controlled, so that the production of unsaturated hydrocarbon materials is held to a minimum. This is a point of considerable difference between hydroforming and thermal reforming, since the gasoline made by thermal reforming contains a higher percentage of unsaturated materials. Because of the low rate of production of unsaturates in the hydroforming process, the rapid formation of heavy, tarry material on the surface of the catalyst is avoided and the activity of the catalyst prolonged.

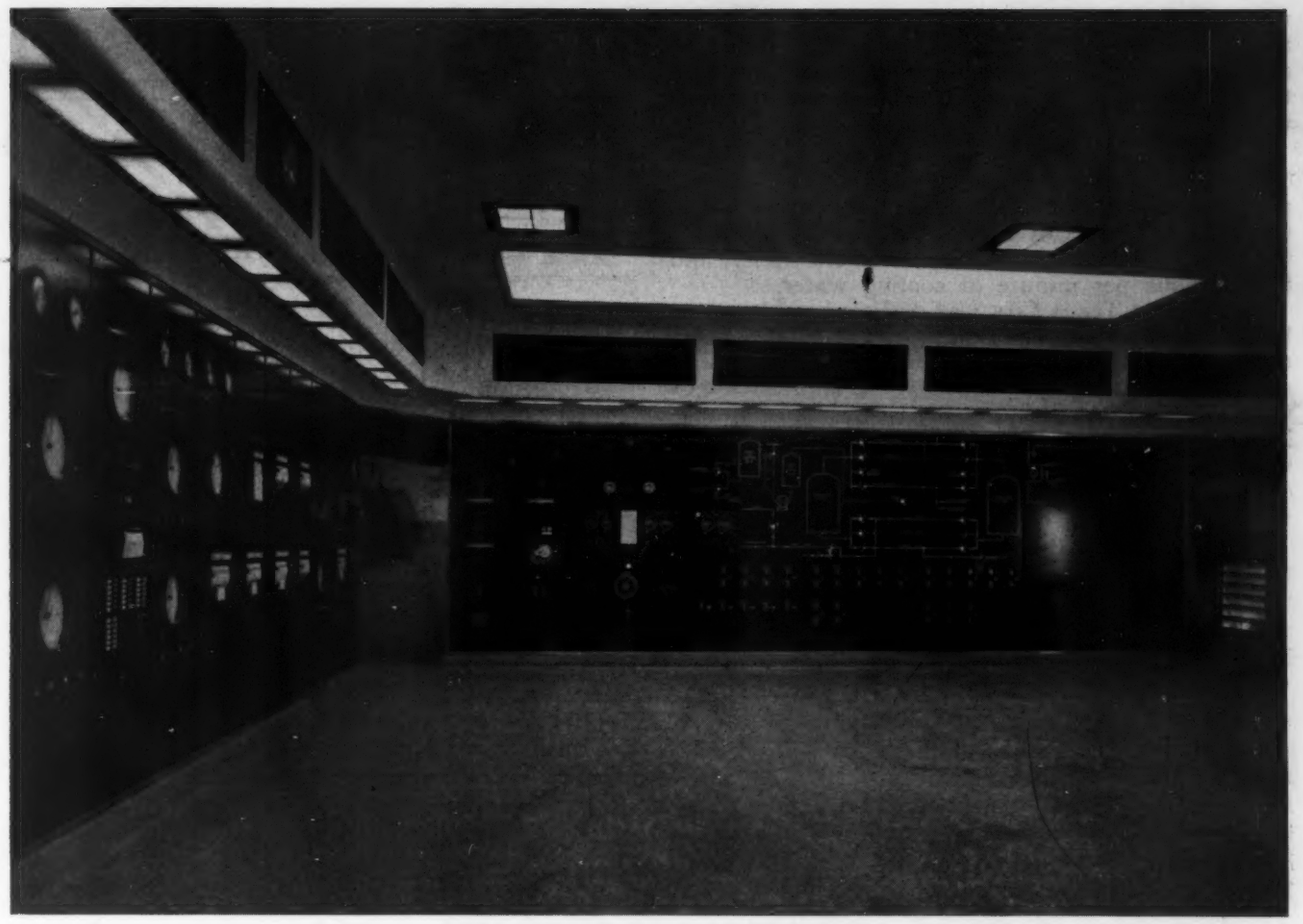
Instead of the creation of large quantities of unsaturates, what does occur is the formation of high-octane materials known as aromatic hydrocarbons. These constitute the chief result of the splitting off of hydrogen atoms from the feed stock, although a number of other changes take place to some extent. It is the presence of the aromatics in the final gasoline that is largely responsible for the high octane number of the gasoline.

How the Texas City unit carries out and controls the process is summarized below and shown on the accompanying simplified flowsheet. An extensive system of heat exchange is omitted from the flowsheet. The charge of heavy, low-octane naphtha, after receiving preheat, is pumped through a furnace. The charge, as it emerges from the furnace, is joined with a stream of gas containing a high percentage of hydrogen, this gas having been previously heated in a separate coil of the furnace. Where the gas comes from will be outlined below. The purpose of heating the charge is not to crack it thermally but to raise it to a temperature where the proper reaction with the catalyst and hydrogen will occur. The mixture of hot charge and gas flows into the top of one of the two catalytic chambers on the unit. It is in the chamber that the charge passes into contact with the granulated catalyst and undergoes the changes described above.

The mixture of liquid materials and gases produced in the process flows from the bottom of the



Simplified flow sheet of 7500-barrel hydroformer unit at Texas City.



Control board for the Hydroform unit

catalyst chamber and, after going through a system of heat exchange, enters a gas separator. A portion of the gas leaves the separator and is discharged eventually into the refinery fuel-gas mains. The remainder of the gas, with its high hydrogen content, is then pumped through a separate coil in the furnace and from the coil emerges to join the stream of hot fresh charge.

The liquid material leaving the gas separator carries some retained gases and then enters a stabilizer, from the top of which the undesired gases are discharged into the refinery fuel-gas mains. Liquid from the bottom of the stabilizer consists of hydroformed gasoline and a small amount of heavy polymer boiling above the gasoline range. The two components are subsequently separated in a rerun tower on the unit. After running to storage the gasoline is blended into finished motor fuel without prior treatment.

The catalytic chambers are provided for alternate operation. During the operation activity of the catalyst slowly declines because of the accumulation of coke and tarry polymer on the surface of the catalyst. When the decline reaches a certain stage the catalytic chamber is automatically taken off-stream and the chamber containing fresh catalyst is connected into the system. After the combustible hydrocarbon gases and hydrogen remaining in the off-stream chamber have been swept out by means of a current of flue gas, air diluted with flue gas to prevent an excessive rate of burning is blown through the chamber. The matter deposited on the catalyst is burned off by this stream of hot gas and air maintained under pressure and at a temperature high enough to cause combustion but not so high as to damage the catalyst. At the end of the burning process the residual air in the chamber is swept out with a stream of flue gas and the regenerated catalyst again is ready for use.

Operation of the regeneration system is wholly automatic. Inasmuch as the periods of regeneration and operation of a catalytic chamber are long, the automatic mechanism is used also to adjust conditions in fractionating towers as changes in activity of the catalyst require adjustments. The unit functions continuously—aside from periods needed for occasional cleanouts and repairs—and at the same time maintains production of a gasoline of uniform quality.

Although operation of the unit is relatively simple, its construction called for considerable skill and ingenuity in design. Almost all the data used in designing the unit had to be derived from pilot-plant studies rather than from an existing commercial unit. One problem was the design of a heater furnace in which thermal cracking would be kept at a minimum in order to cut down heavy coke deposition on the catalyst. Another basic problem was to establish the proper proportion between the sizes of the recycle gas system and the regeneration system, whose functions are closely interrelated. Alloy steel tubes were used in the furnace to resist high temperatures and the effect of hot hydrogen gas. The use of heat exchange equipment is extensive. Auto-

matic devices are widely used for reasons of safety and economy. Recording and indicating instruments are connected to a central control board to save time and maintain the unit constantly under observation.

Only six men per shift are required for operation of the unit. When the unit is charging 7500 barrels per day its typical utility consumptions are: 117,000,000 Btu. per hour of furnace fuel, 42,000 pounds per hour of steam, 2000 kilowatts of electricity, and 8800 gallons per minute of cooling water.

The unit at Texas City was designed to charge at least 7500 barrels daily of 40 to 45 C.F.R.-M. octane number virgin naphtha and produce from it a minimum of 80 volume percent of gasoline having a C.F.R.-M. octane number of 80. However, by changing operation conditions or feed stocks, different yields of gasoline of various octane numbers may be obtained. Either straight-run or cracked naphthas may be charged to the unit.

The production of heavy polymer is quite low—2 to 3 volume percent of the charge for which the unit was designed. Net gas production amounts to about 16 percent by weight of the charge when taking a gasoline yield of 80 percent by volume.

In Table 1 are tabulated typical data on the charge stock and the hydroformed gasoline product.

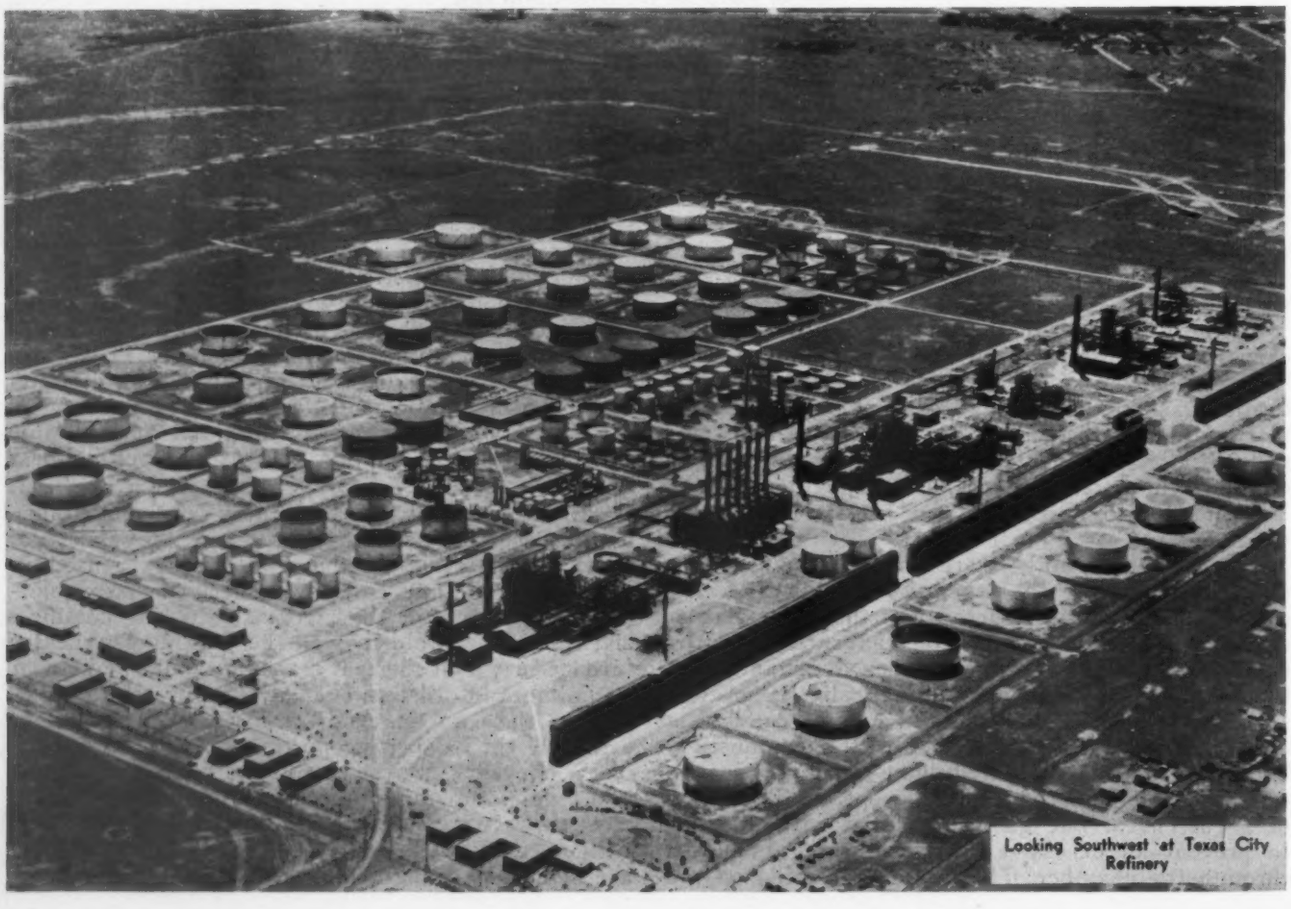
The gasoline is highly aromatic. It contains between 45 and 50 volume percent of total aromatic hydrocarbons, of which between 15 and 20 percent is toluene. The other aromatics are xylenes and higher-boiling aromatic hydrocarbons. Unsaturated hydrocarbons are present in relatively small amounts in the gasoline, probably not over 10 percent by volume. The low percentage of unsaturated material in hydroformer gasoline makes it possible in general to put the product directly into finished motor-fuel blends without prior acid treatment.

TABLE 1

	Charge	Gasoline
Gravity, °A.P.I.	51.4	51.3
Oct. No., C.F.R-M.	47.2	77.0
Reid V.P.	0.4	8.2
A.S.T.M. Dist.:		
I.B.P., °F.	222	99
10 Percent	250	174
50 Percent	292	270
90 Percent	367	339
F.B.P., °F.	436	368

The hydroforming process is capable of producing gasoline of aviation grades, although as operated at present the unit at Texas City is making motor fuel only. Octane rating of the gasoline may be raised by altering operation conditions.

The fact that there is a large amount of toluene in the gasoline is of importance. On the basis of charging 7500 barrels daily of naphtha feed it is estimated that the potential toluene production of the hydroformer amounts to about 5,000,000 gallons per year, approximately a fourth the total toluene produced in the United States during 1939. It is readily apparent that the installation of a few large units provided with equipment necessary for the recovery of nitration-pure toulene could meet any conceivable need for toluene for military purposes.



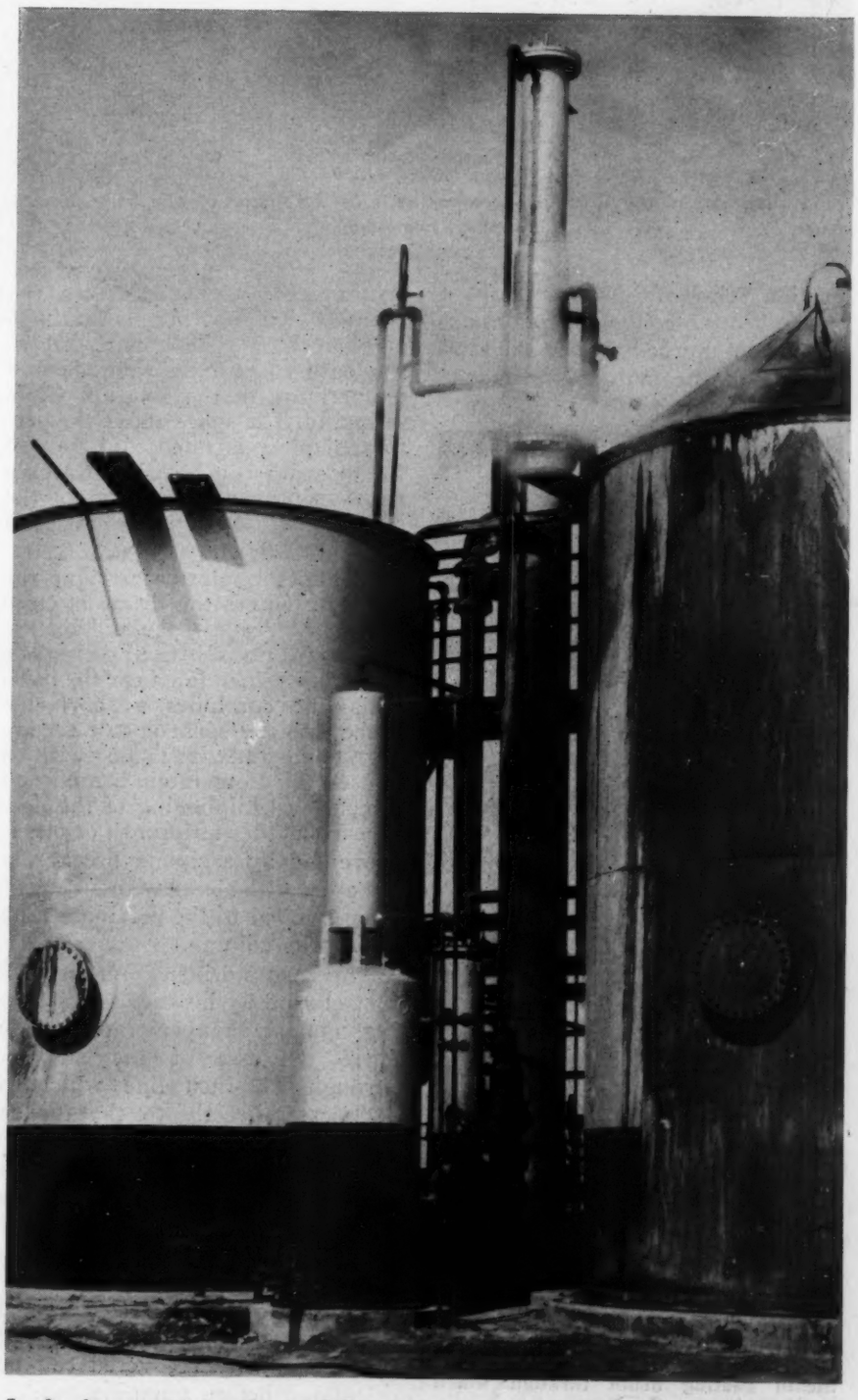
Looking Southwest at Texas City Refinery

Fractionation and Condensation Recover Distillate from Doctor Solution

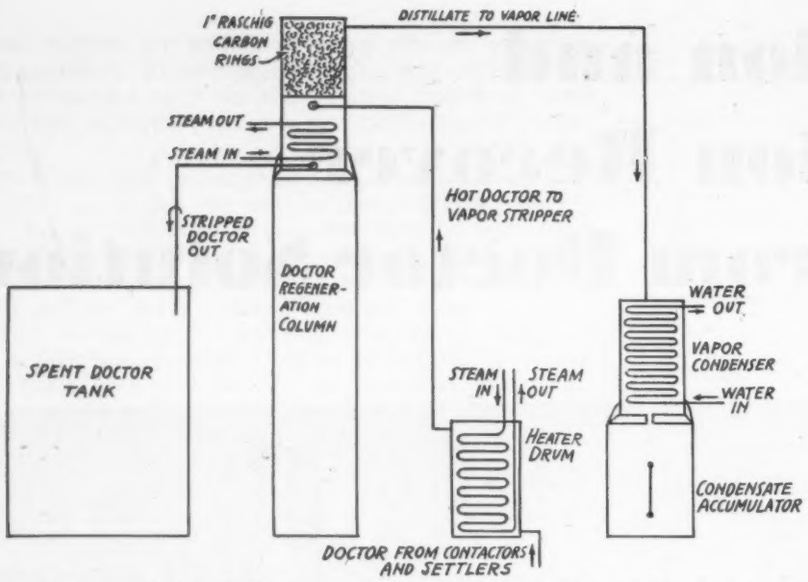
RECOVERY of distillates from spent doctor solution is being accomplished by Fletcher Oil Company, Los Angeles, through a series of heaters, flash and fractionating chambers and a water-cooled vapor condenser. Since the solution is used as a once-through contact, pumped from the supply tank to the distillate contactors, settling drums and spent storage, the partially emulsified solution entrains a substantial quantity of the treated gasoline that is not broken out in the settling tanks. The recovery system is connected into the transfer line which leads the spent doctor from the settlers to the receiving tank, and consists of a steam-heated doctor heater, a combination flash, heating and stripping column and a water-cooled condenser for recovered vapors mounted above an accumulator drum. The spent doctor is then led to the same tank as before, from which it is subsequently recirculated through a regeneration unit for reconditioning.

The first item in the system is the steam-heated doctor heater, made from a five-foot nipple of 10-inch pipe containing two heating coils. One coil has 100 feet of ½-inch pipe wound on a mandril before installation. The other is a longitudinal coil containing 50 feet of 1-inch pipe, inserted as a core for the ½-inch helical coil. The heater is fitted with companion flanges at each end, the lower being a blank and the top drilled and tapped for connections to the inlet and outlet of the steam coils. Side connections, one at the base and one near the top, with 2-inch fittings are used as inlet and outlet for the doctor solution to pass through the heater.

The combination flash and stripping section is mounted on the doctor solution regenerator column. This section is 6 feet of 10-inch pipe, with companion flanges at each end and divided in two parts by a perforated plate. The



In the foreground are the condenser and accumulator. The stripper is at the top of the regenerator column, with goose neck showing at the left.



Flow diagram of the distillate recovery unit in the plant of the Fletcher Oil Company, Los Angeles.

section below the plate contains a steam heating coil and a spray nozzle turned upward against the lower side of the plate to break the doctor solution as it enters the chamber. The heating coil is made of 25 feet of ½-inch pipe, set in the base to maintain the desired temperature of the solution while stripping. The space above the perforated plate is filled to 1 foot of the top with 1-inch carbon Raschig rings to prevent carry-over of the doctor solution with the stripped distillate vapors.

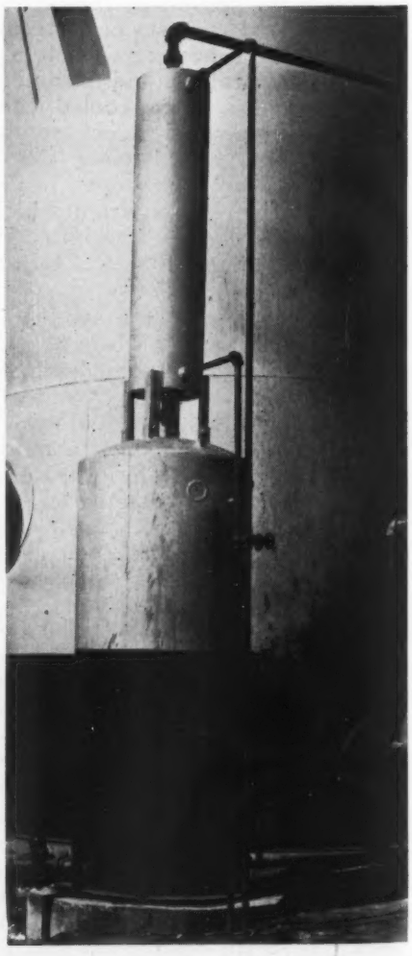
Steam heating drum through which doctor solution is pumped to recover entrained distillate.

The doctor solution carrying the distillate enters the drum as close to the lower side of the mid-section plate as possible and leaves through a 2-inch line near the base. This line continues a short distance into the spent-doctor receiving tank and is made with a goose-neck to maintain a predetermined level. Siphoning of the doctor from the stripping drum is prevented by a siphon breaker at the apex of the bend with an equalizing line led to the receiving tank beside the column.

The vapors driven from the doctor solution by heating and spraying against the perforated baffle leave the top of the stripper through a 2-inch line which is connected directly to the top of the distillate condenser. The condenser is a 6-foot section of 10-inch pipe filled with ½-inch pipe coils through which cold water is pumped to cool the distillate before it enters the accumulator below. The accumulator is equipped with a gauge glass and is strapped so the quantity recovered can be calculated before pumping out.

Recovery of condensate by this system averages about 10 percent of the volume of doctor solution passed through the stripper. If, for example, the treating plant requires 3500 gallons of doctor solution to sweeten cracked gasoline over a definite period, the amount of condensate recovered from the stripper averages about 350 gallons. The quality of the recovered distillate is on a par with the pressure distillate made in the cracking plant, and is blended with that material upstream from the inhibitor mixer.

The steam used to heat the doctor solution in the first heater and in the base of the flash-stripper column is taken from the plant main but is not super-heated. The temperature maintained on the stream of doctor through both heaters is approximately 215° F.; above the boiling point of water, but below the boiling point of the doctor solution itself. Pressures maintained through the system are as near atmospheric as possible so that the distillate in the doctor solution will distill without the hindrance of back pressure.



Closeup of the vapor condenser and accumulator tank.

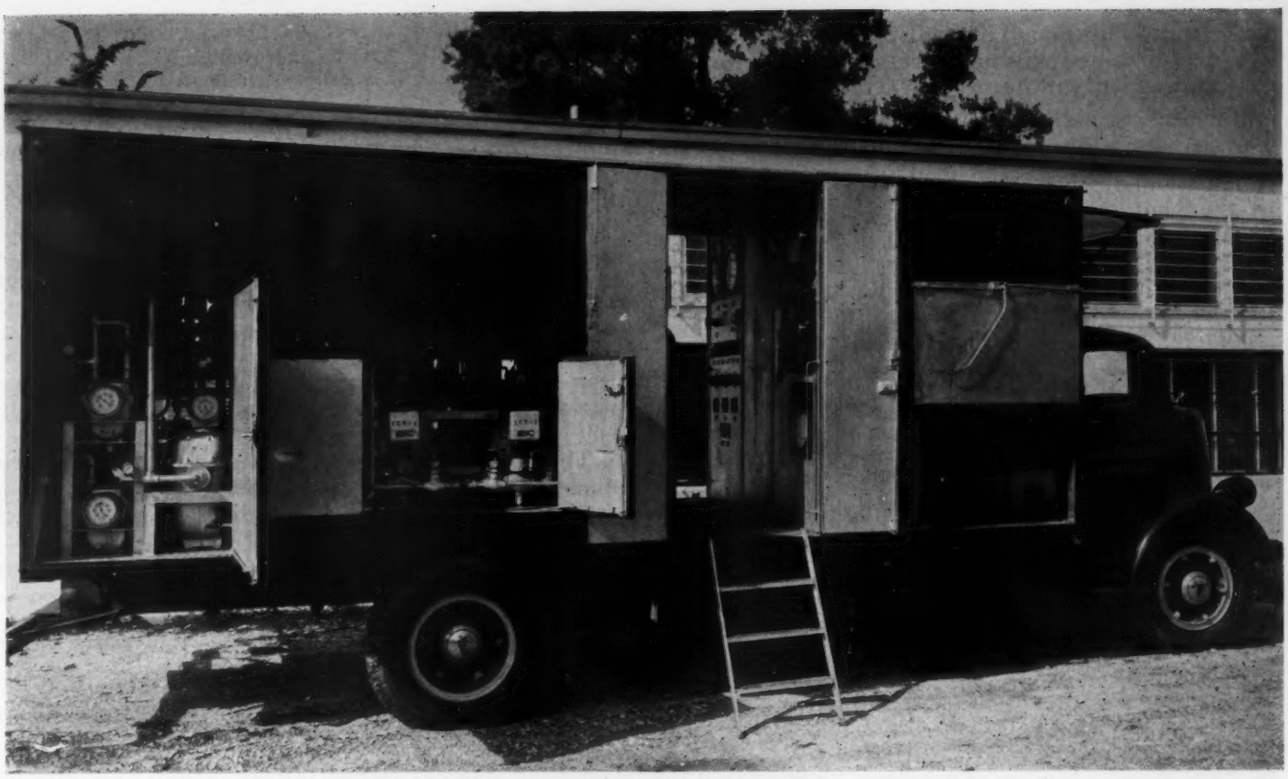


FIGURE 1—Mobile recovery unit from the meter side

Mobile Unit for Studying Condensate Recovery

H. M. NELLY, JR. and M. BENEDICT
The M. W. Kellogg Company

THE trend towards operation of condensate-recovery plants at progressively higher pressures above 1500 pounds per square inch has introduced a number of new chemical-engineering-design problems. Solution of these problems in the laboratory is difficult, and their analysis by calculation based on available physical data is uncertain. A suitable approach to these problems is the use of equipment which simulates the operation of a commercial-sized installation and which can be moved to a location where it may be operated on the feed for the proposed commercial unit. This article describes such equipment and presents typical results obtained from its use in the Gulf Coast area.

The design of any high-pressure recovery process is primarily dependent upon the use of vaporization equilibrium constants. The amount of lean oil required to effect a desired recovery of condensate and butane, the amount of lean oil loss in the dry residual gas leaving the absorber, and the quantity of low-pressure gas from the flashing system together with the loss of desirable components in this gas are directly related to these equilibrim constants. At high pressure the constants for the hydrocarbons become increasingly sensitive to the particular composition of the feed and the type of process employed. Further, the higher the pressure, the more difficult it is to predict these constants.

In evaluating the economics of a condensate-recovery project, a knowledge of the characteristics of the material to be produced, especially the gasoline, is essential. These characteristics, as determined on liquid taken from a field separator, will differ from those which would be produced in a commercial plant because of the improved recovery of the more volatile constituents in the latter. This applies not only to the boiling range of the gasoline but also to its octane rating.

When the type of equipment described in this article is run on the feed for the commercial unit, utilizing the same type of process at the same temperature and pressure, the results will be directly comparable with those which would be obtained in the commercial unit, thus eliminating all uncertain-

ties in equilibrium constants. Furthermore, the products obtained will have the same characteristics as those which will be produced by the commercial installation.

Description of Equipment

The mobile condensate recovery unit is illustrated in the photographs, Figures 1, 2, and 3. The diagrammatic flow through the unit is shown in Figure 4. The unit is a complete recovery plant mounted on a truck, which can be driven to the point where the high-pressure condensate stream to be studied is available. It has been so designed that it may be operated in any one of the following three conventional types of recovery processes:

1. Atmospheric Temperature Absorption
2. Low-temperature Absorption
3. Low-temperature Separation

The unit can be operated over the following range of variables:

Well-head Pressure: Up to 6000 pounds per square inch.
Primary Tower Pressure: Up to 5000 pounds per square inch.
Primary Tower Temperature: —10° to +120° F.
Feed Rate: 500 to 1200 Standard cubic feet per hour.
Lean Oil Rate: 0 to 5 gallons per hour.

The unit proper, that is, the towers, piping, valves, and meters, are located in the rear compartment of the truck body, as shown in Figure 2. Forward of these is the control compartment, Figure 3, in which are mounted instruments for the measurement and automatic control of pressures, temperatures, liquid levels, and rates of flow. In the front compartment is located the equipment for providing utilities. This equipment consists of an air-cooled gasoline engine, which is the prime mover for the unit, generator, lean-oil pump, air compressor, and refrigerating apparatus. It should be noted that the unit is entirely self-contained and requires no external utilities.

The control of the operation of the unit has been made as nearly automatic as possible. This results in even operation and reduces the operating personnel to a minimum.

Referring to Figure 4, the feed enters the unit at the primary separator (F-1), where a separation is made between water, hydrocarbon liquid, and hydro-

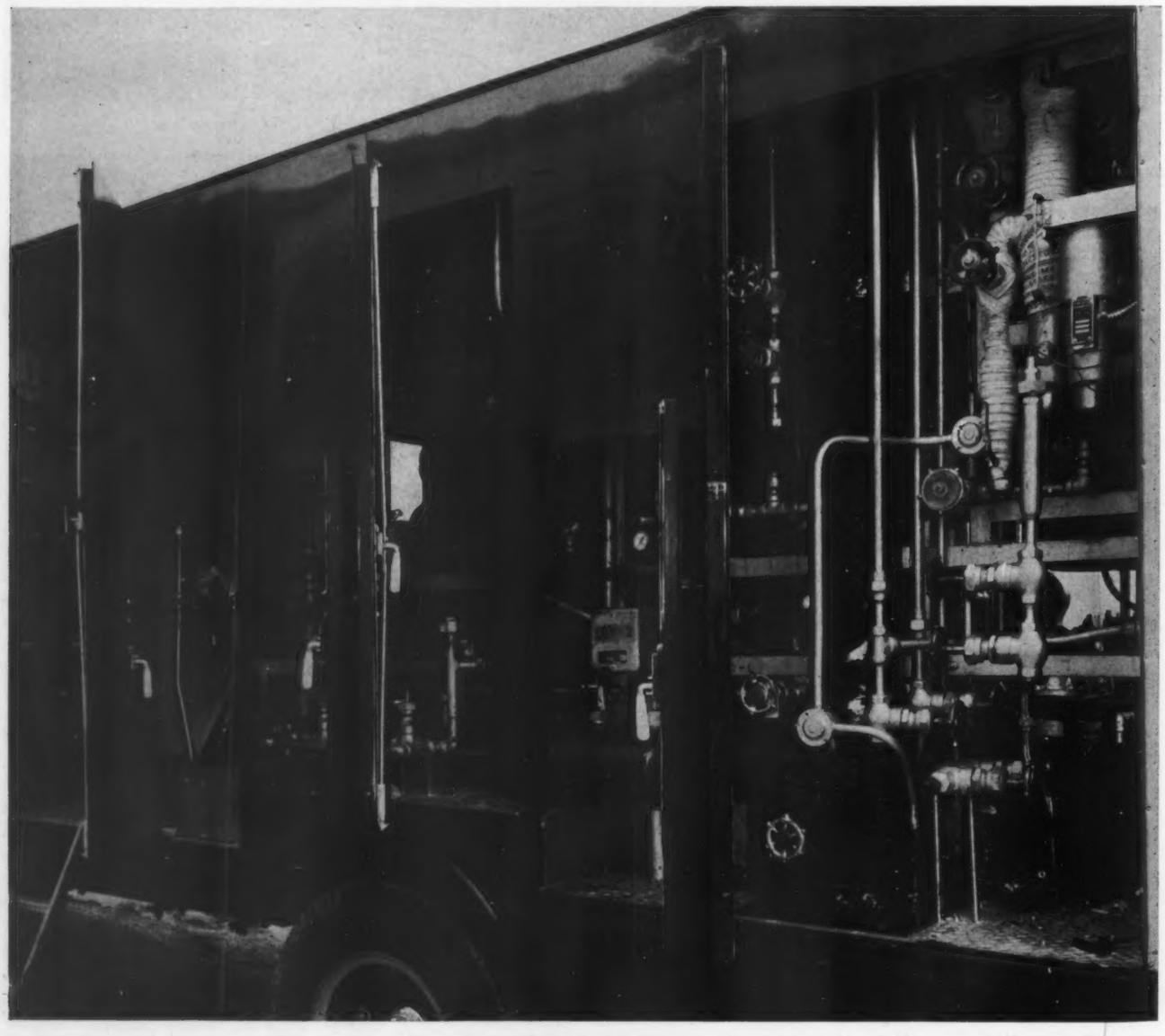


FIGURE 2
Processing Equipment

carbon vapors. The gas from the top of F-1 is dried by contact with an activated gel in the drier (F-2). It then passes through an electrically heated exchanger (H-1), pressure control valve (PC-2), and cooler (C-1), by means of which its pressure and temperature are brought to the conditions desired for the principal separation.

The bottom of F-1 is provided with a leg equipped with an electrically operated water-level indicator and discharge valve. The hydrocarbon liquid from F-1 flows through the liquid level controller (LLC-3) and joins the gas stream after PC-2.

The stream leaving the cooler (C-1) enters near the bottom of the primary tower (E-1), where it is separated into liquid and vapor. In absorption-type operations, lean oil is fed from the calibrated tank (F-6) by the pump (J-1) through the cooler (C-2) to the top of E-1, where it flows countercurrent to the hydrocarbon gases. The gas leaving the top of E-1 flows through the electrically heated exchanger (H-2) and the flow control valve (FC-1) to the retrograde condensate accumulator (F-3). This vessel, operated at substantially atmospheric pressure, collects lean oil or condensate which may have been precipitated from the gas stream leaving E-1 upon pressure reduction. The gas leaving F-3 flows through an orifice actuating the flow-control valve (FC-1), establishing the throughput for the entire unit. The dry meter (M-1) measures the volume of this gas at atmospheric pressure.

The liquid from the bottom of the primary tower (E-1) flows through the liquid-level controller (LLC-2), where it is throttled into the flash drum (F-4). Here the flashed vapor is separated from the liquid at a pressure intermediate between atmospheric and that prevailing in E-1. The gas from the top of F-4 is discharged through an electrically heated exchanger (H-3) and a pressure controller (PC-1), and is then measured by dry meter (M-2).

The liquid from the bottom of F-4 passes through the liquid-level controller (LLC-1) and the electrically heated exchanger (H-4), being discharged into the low-pressure flash drum (F-5). Here, a final separation is made between gas and liquid. The gas is discharged through the pressure controller (PC-3) and is measured in the dry meter (M-3). The liquid is accumulated and measured in F-5.

Refrigeration is effected by an air-cooled vapor compression freon refrigerating system.

Concurrent Absorption Optional

The foregoing describes the most complete utilization of the unit. When operating without refrigeration, the coolers may be by-passed, and when operating without absorption, no lean oil is used. If desired, the intermediate flash drum (F-4) may also be by-passed. Connections have been provided for concurrent absorption operation, wherein lean oil from the pump (J-1) is charged directly into the total feed before the cooler (C-1).

The high-pressure vessels are made of alloy steel, 4 inches outside diameter by 2 inches inside diameter. They are connected by ½-inch double extra-heavy pipe with appropriate fittings. All joints except a few essential unions are brazed or welded. All high-pressure piping is designed for 6000 pounds per square inch working pressure.

The bottom section of the primary tower (E-1) is a flash chamber 21 inches high. Above this is a 39-inch absorption section, packed with 5/16-inch i.d., 1⅛ turn stainless steel helices. Lean oil is introduced directly above this section. At the top of the tower is a mist-extracting section to prevent mechanical carry-over of liquid. This section is packed with a 12-inch layer of metal helices. Similar mist-extracting sections are provided in all vessels where liquid and gas are separated. The primary tower (E-1) and the flash drum (F-4) are fitted with special, reflex-type sight glasses, made of transparent lucite.

Provision is made for measuring the pressure and temperature of the various streams at the points indicated in Figure 6. Samples may be taken at the top and bottom of all towers and drums. In this way, a complete study may be made of the processes taking place in each of the vessels, and component balances may be made over several sections of the unit to check the reliability of the data.

Operating Data

To illustrate the type of information which can be obtained from the operation of the unit, the results of two typical test runs are presented. Both tests were absorption runs made on the same feed under identical operating conditions, with the exception of the temperature of the absorber. The operating conditions and principal results of these runs are given in outline in Table 1.

Table 2 gives the pressure, temperature, and composition of the feed entering the unit. The composition of the feed was evaluated by compositing the

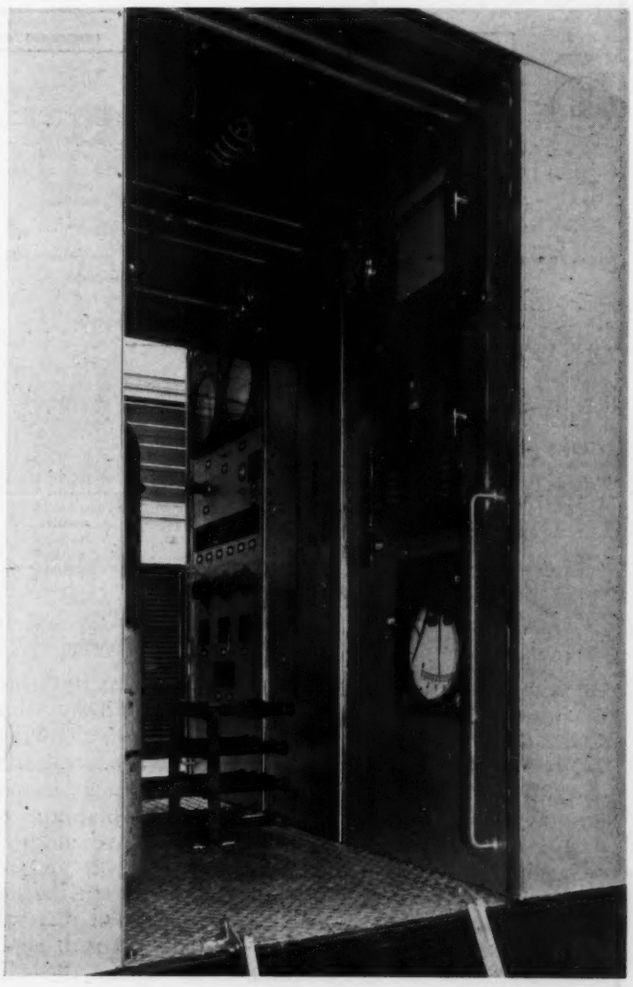
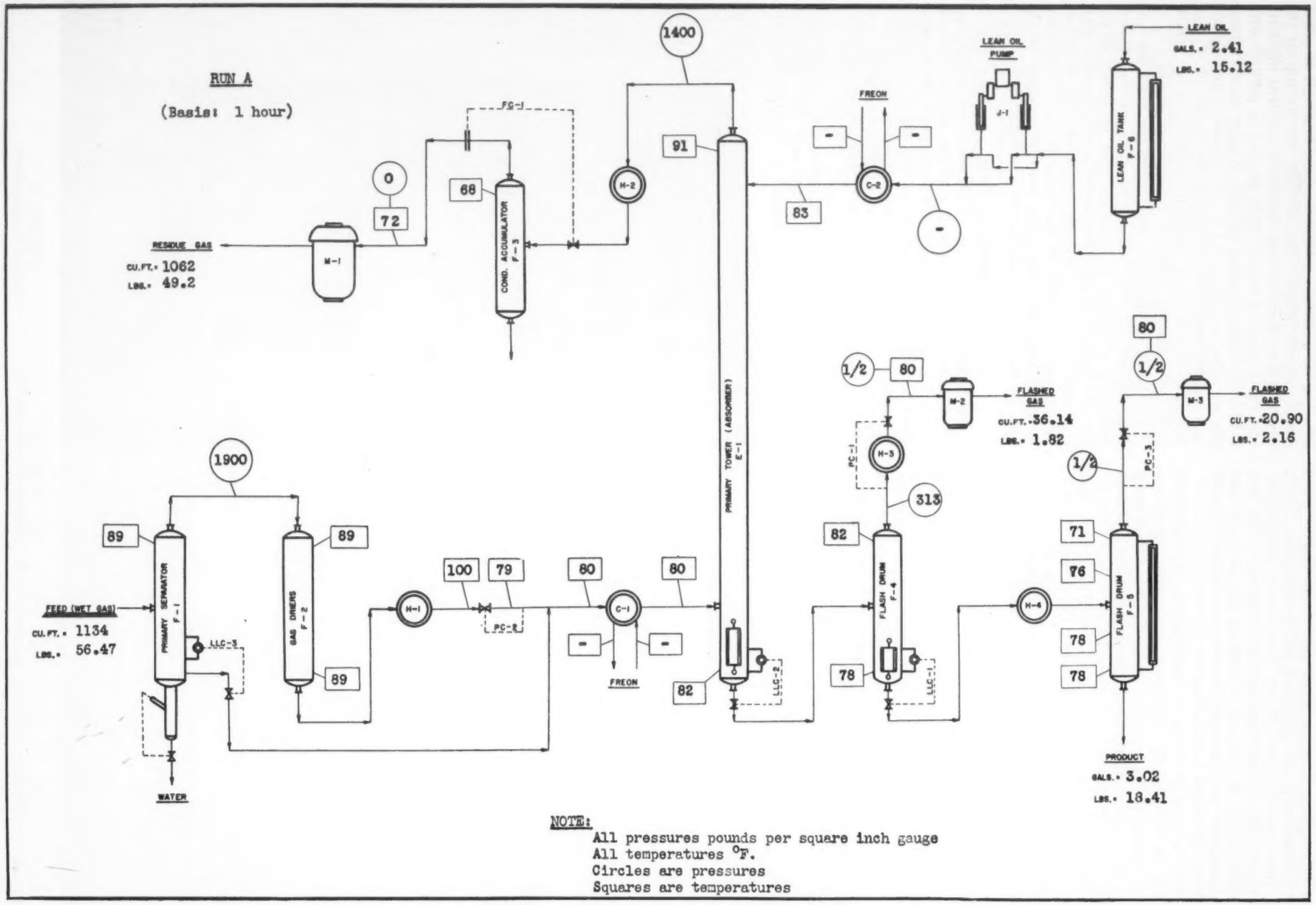


FIGURE 3
Control Compartment



NOTE:
All pressures pounds per square inch gauge
All temperatures °F.
Circles are pressures
Squares are temperatures

FIGURE 4—Flow Diagram and Operating Data

TABLE 1
Operating Conditions

Test No.	A	B
Type Operation	Atmos. Temp. Absorption	Low Temp. Absorption
Absorber Pressure (Lbs./sq. in.)	1400	1400
Absorber Temperature (°F.)	82	37
Feed (S.C.F./hour)	1134	1180
Absorber Dry Gas (S.C.F./hour)	1062	1056
Gas Shrinkage (% on Feed)	6.35	10.52
Lean Oil:		
Gallons per hour	2.41	2.35
Gals. per 1000 S.C.F. of Feed	2.13	2.00
Distribution of Pentane Plus: (Gals. per 1000 S.C.F. of Feed)		
Feed	0.645	0.641
Absorber Dry Gas	0.170	0.051
Absorber Rich Oil	0.475	0.590
Recovery in Absorber: (% of Component in Feed)		
Methane	3.34	4.64
Ethane	14.14	23.10
Propane	27.70	50.50
Butane	51.70	80.20
Pentane Plus (*)	73.90	93.10

(*) Lean oil loss has been taken into account in this value, therefore, it represents the net recovery of pentanes and heavier.

dry absorber gas with the absorber rich oil and deducting the lean oil. It is interesting to note the close agreement in the composition of the feed as determined in this way.

Temperature, pressure, and quantity details for Run A are given on the flow sheet in Figure 4. Detailed component balances on the intermediate flash drum (F-4) and the low pressure flash drum (F-5) for this run are presented in Tables 4 and 5.

Discussion

Referring to Table 1, examination of the distribution of the pentane plus fraction and the percentage recovery of the various components shows the marked effect of lowering the absorber temperature. In lowering this temperature from 82° F. to 37° F., while maintaining the pressure and lean oil rate substantially constant, the amount of pentane plus in the absorber dry gas is decreased from 0.17 to 0.05 gallons per 1000 cubic feet. Expressed in another way, lowering the absorber temperature raises the recovery of pentane plus from 73.9 to 93.1 percent.

The values reported in Table 1 for the percentage of pentane plus have taken into account the lean oil loss from the top of the absorber and are therefore net values. The percentage of this material entering with the feed which is retained by the absorber is higher than that reported, but in arriving at the net recovery the lean oil loss has been deducted. This reasoning does not apply to hydrocarbons lighter than pentane, since they are not present in the lean oil. It should be pointed out that the rather high loss of pentane plus is to a great extent attributed to the low initial boiling point of the lean oil, inspections of which are given in Table 3.

Table 1 also shows that lowering the absorber temperature not only increases the recovery of the more desirable constituents but also that of methane and ethane. This results in a greater gas shrinkage at the lower temperature and a corresponding increase in the amount of low-pressure flashed gas.

The accuracy of the results obtained from the unit depend not only upon its operation but also upon the ability to collect a representative sample, to transport it without leakage or contamination to the laboratory, and to analyze it correctly. There are certain checks which can and should be made before the data are accepted. One of these has already been given in the comparison of the component analysis of

TABLE 2
Feed Characteristics

Test No.	A	B
Pressure (Lbs./sq. in.)	1900	1900
Temperature (°F.)	110	110
Composition (Mol. %):		
Methane	91.59	92.02
Ethane	3.18	3.20
Propane	2.34	2.03
Butane	1.39	1.26
Pentane Plus	1.50	1.49
Total	100.00	100.00
Molecular Weight	18.91	18.81
Gals/1000 of Pentane Plus	0.645	0.641

TABLE 3
Characteristics of Lean Oil

Gravity—°A.P.I.	56.2
A.S.T.M. Distillation:	
I.B.P.	211
5 Percent	231
10 Percent	236
20 Percent	243
30 Percent	250
40 Percent	260
50 Percent	271
60 Percent	287
70 Percent	308
80 Percent	340
90 Percent	401
95 Percent	462
E. P.	493
Percent Recovery	97.0
Percent Residue	2.0
Percent Loss	1.0

TABLE 4
Operation of Intermediate Flash Drum (F-4)

Test No.	A
Pressure (Lbs./sq. in.)	313
Temperature (°F.)	78

	OUTPUT			INPUT
Component Balance (Lbs/hr.)	F-4 Gas	F-4 Liquid	Total	E-1 Liquid
Methane	1.34	0.27	1.61	1.46
Ethane	0.17	0.23	0.40	0.40
Propane	0.15	0.73	0.88	0.85
Butane	0.11	1.20	1.31	1.27
Pentane Plus (*)	0.05	18.15	18.20	18.41
Total	1.82	20.57	22.39	22.39

(*) Includes Lean Oil.

TABLE 5
Operation of Low-Pressure Flash Drum (F-5)

Test No.	A
Pressure (Lbs./sq. in.)	0.5
Temperature (°F.)	71

	OUTPUT			INPUT
Component Balance (Lbs./hr.)	F-5 Gas	F-5 Liquid	Total	F-4 Liquid
Methane	0.35	....	0.35	0.27
Ethane	0.27	....	0.27	0.23
Propane	0.60	0.18	0.78	0.73
Butane	0.71	0.69	1.40	1.20
Pentane Plus (*)	0.23	17.54	17.77	18.14
Total	2.16	18.41	20.57	20.57

(*) Includes Lean Oil.

the feed for runs A and B in Table 2. Although it is not possible to make material balances around the various sections of the unit, nevertheless, partial checks of this nature are afforded by component balances around the flash drums (F-4 and F-5). These component balances depend upon the determined composition of all streams entering and leaving the drums, the measured output quantities, and the computed input quantities. Such component balances for Run A are shown in Table 4 for the intermediate flash drum (F-4), and in Table 5 for the low-pressure flash drum (F-5). Comparison of the input and total output quantities of the individual components shows the data to be reliable.

Trends of Lubricating Oil Manufacture and Utilization

MALCOLM H. TUTTLE
Max B. Miller & Company, Inc.

THE trend today in the field of engine design continues to be towards higher temperatures and higher pressures and this must continue because this is in the direction of greater fuel economy. The limit is only that imposed by the materials for construction, the combustion characteristics of the fuels and the lubricating characteristics of the oils. Since engines are now designed on the basis of the higher quality oils, it becomes necessary for the manufacturers of the lower grade oils to suit their product to the engine.

By the solvent treatment of properly selected stocks, oils of high viscosity index and of excellent stability can be produced. Additives should be employed to supplement deficiencies of the raw stock and not to replace the best refining methods.

The value of the lowest viscosity oils now in use is questioned but if their use is to be continued, it is proposed that extensive engine tests be conducted to determine the film stabilizing effect of including in such oils solvent refined residual fractions.

This paper was presented before the annual meeting of the Western Petroleum Refiners Association, Hot Springs, Arkanas, April 17, 1941.

IT IS only in the last few years that trends in motor oil quality and for that reason, the trends in oil processing could be said to depend on the trends in engine design and performance. There was a time when the refiner, accepting the limitations of his crude, turned out an oil characterized by the crude and although there was an appreciable difference between the best and the worst of these oils, that difference was not often indicated to the driver by engine performance. This was largely due to the fact that car owners had been educated into the belief that a viscous oil was the best lubricant and that the crank case should be drained every 500 miles. Furthermore, the engine manufacturers designed and built with the performance of lower quality oils in mind. Even the materials of construction, iron for castings and babbitt for bearings, were better suited for good oil performance than the assortment of iron, aluminum, magnesium, chromium, copper, lead, cadmium and silver that may be found in today's engine.

The change that has occurred in the materials selected for engine construction indicates an important change in the attitude of the engine builder. He has stopped the practice of permitting the ordinary material to limit performance. Design today is based on that material, that fuel and that lubricant, which has proven its high quality and the proving is not being left to the random methods of the motoring public but is being conducted on engines in modern torture chambers with scientists and engineers recording every engine whimper and noting every failure. Thus, development today is a competition between the designing engineer and the testing engineer, and in this competition the refiner, as a supplier of both fuel and lubricant is, or should be, the designer's right-hand man.

We have continuously, as good right-hand men, made available to the designer better fuels and better lubricants and, at least as far as the fuel was concerned, immediate use was made of the improved quality. It is interesting to note that the chief improvement in gasoline quality was an increase in its anti-knock characteristics which could be accurately measured by engine tests. The improvement in lubricating oil quality which was made possible by solvent refining was not as quickly evaluated because of the confusion caused by using laboratory determined characteristics as a measure of quality. As a result, it was thought by some that thermal stability and resistance to oxidation were a function of viscosity index. It was stated by others that the oil might be "over-refined" in obtaining high viscosity index and that loss in stability would result. It was only by putting the new lubricants through extensive engine tests, involving all possible conditions of running and loading that a better understanding of lubricant quality has been obtained. These tests show that lubricant quality may be affected by a change in:

1. Crude source
2. Crude fraction
3. Refining process
4. Oxidation inhibitor
5. Detergent or suspension agent

Evaluation of lubricants on the basis of engine tests is sometimes difficult because of the many factors of engine condition and operation which must be measured and analyzed. Engine test runs are now being conducted not only by the engine manufacturers but also by the refiners and although results and conclusions are at times inconsistent, it is now generally recognized that high viscosity index in itself does not guarantee the highest stability, although the most stable oils are almost without exception of high viscosity index. It is indicated that

there is a difference in the natural stability of solvent extracted lubricants which is dependent not only on the source of the crude but on the fraction of that crude utilized for lubricating oil production. It is known that the stability decreases with viscosity and that the highly refined residual oils are more stable than overhead oils from the same stock and when added to the overhead oils, increase their resistance to oxidation. This improvement of stability by blending is of interest since it usually results in giving to the blend a viscosity index higher than that of either of the fractions. More work should be done by all engine laboratories on the benefits to be obtained by the use of the solvent refined viscous residual fractions in blends with low viscosity neutrals. This problem is of particular interest in increasing the stability and film strength of 10-W and 20-W oils.

It might also be argued with some logic that the engine designers have been forced to consider the lubrication of their engines during the winter with the most unstable fraction of the crude and that oils of such low viscosity might be eliminated as lubricants if a thorough study were made of the related problems of cold starting, wear, lubricant and fuel consumption as affected by viscosity, carburation, ignition and cranking speed. This study is proposed in spite of the fact that discussions with engine men representing not only automobile manufacturers but also, strangely enough, refiners, indicate that the 10-W grade is too firmly established ever to be abandoned. If this be true, it is then of even greater importance that a careful investigation be made to determine the degree of improvement which is made possible by blending methods. This is of interest to the refiner because an increase in the natural stability of the lubricant decreases the cost of added inhibitor. It is of interest to the engine designer because increased stability of the 10-W and 20-W grades is required for an increase in engine output and it is of interest to the motoring public who will probably never again drain at 500 miles and who will never know when an added inhibitor has been used up or when a detergent has ceased its suspending activities.

Any discussion in regard to the possibility of decreasing the use of additives by increasing the natural stability of a refined oil must not be considered as a criticism of the use of such materials, since additives are strongly recommended for rectifying oil deficiency after choice of crude and the best refining methods have reduced such deficiencies to a minimum.

New Duties Imposed by Engine Development

In order to understand oil deficiencies and the means of eliminating or correcting them, a brief study of new duties imposed by change in engine design should be considered.

The general distribution of motor fuels with higher and higher octane rating at little or no increase in price, caused the engine manufacturers to rapidly increase the power output of their engines through the use of higher compression ratios. The result has been improved engine performance and efficiency at the expense of higher engine temperatures and pressures. In themselves, the temperature and pressure would not be the cause of lubrication failure but oil films at higher temperature and in the presence of air and metal catalysts may deteriorate rapidly when the oil has been poorly refined. Failure is commonly indicated by stuck rings, lacquer deposit, sludge, burned out bearings, excessive wear and increase in knocking tendency. Of these failures, all but the last two are greatly affected by the ability of the lubricant to withstand oxidation. Increase in wear and tendency to knock are only to a slight extent affected by oxidation but they complicate the problem of lubrication since the simplest method of decreasing wear would be to increase oil flow along the cylinder walls but this method increases combustion chamber deposit and thereby the tendency toward knocking. For this reason and also because of oil economy, cylinder, piston and ring wear are best reduced and controlled by an increase in the stability and strength of the lubricant film so that no increase in lubricant flow past the piston is required. It is necessary, however, to considerably increase the amount of lubricant supplied at the base of the piston to help dissipate greater quantities of heat from the cylinder walls. The new duties imposed on the lubricant by the engine are readily borne by the lubricant when an increase in its oxidation resistance protects it from one type of failure and an increase in film stability and strength protects it from other types of failure.

Improving Lubricant Quality by the Use of Additives

In recent years, there has been a growing tendency to improve the quality of petroleum lubricants by compounding with materials to increase viscosity index, decrease pour, improve oxidation resistance, add detergent characteristics and increase film strength. The discovery and development of such additive materials has been a great achievement but there is no "cure-all" additive that can eliminate improper refining and selection of stocks. It is only after the best job has been done in the refinery that the use of additives should start. This is true not only because of economy but also because the life of the poorly refined oil can be no longer than that of the additive and when the life of the additive is short and the time between drainings is long, all those failures may occur, to avoid which, additives were first employed.

When the oil is well refined from proper stocks, all S.A.E. grades may give suitable service without the use of additives, but their use may still be advisable to further insure the best performance and in this case, exhaustion of the additive does not bring about a sudden and rapid deterioration of the oil as is likely to occur in the case of the oil of poor quality.

Of the many additive materials which have been proposed, some have become well established. The pour depressers, for example, are widely used for production of low pour 10-W and 20-W oils. A number of effective oxidation inhibitors have been developed and placed into commercial use, particularly in heavy-duty and aviation service, where they are effective in reducing ring sticking, lacquer and sludge formation and bearing failures.

Additives for improving film strength have not been generally adopted which is partly due to the fact that many compounds which increase the strength of the film at moderate or low temperatures have been found to promote decomposition of the film under combustion chamber conditions. In this

connection, it is felt that improvement should be made in film strength only when this can be done without decreasing film stability.

Improvement in Lubricant Quality by Solvent Extraction

When the lubricant fractions of a crude are treated by selective solvents, a separation into fractions may be made. The choice of the solvent or solvents is governed by the nature of the stock to be treated and by characteristics which are desired in the finished products. Solvent extraction differs not only as to the solvents employed but as to the method of their use. In this respect, the field may be divided into single solvent and into double solvent extraction systems. As examples of the processes which are based on the use of single solvents, there are: propane, which is used to hold low molecular weight fractions in solution and precipitate the higher molecular weight asphaltic fractions; and furfural and phenol which are alternatively used in the treatment of asphalt-free stocks for the separation of paraffinic from non-paraffinic fractions. As an example of double solvent treatment, we have the Duo-Sol process which employs the counterflow of a paraffinic and a naphthenic solvent, so that the raw stock is simultaneously treated by both solvents.

Since both the single and double solvent systems have been thoroughly described and since their wide use has made the details of their design and operation familiar to most oil refiners, only a brief outline will be given here of the Duo-Sol process.

The counterflow of paraffinic and naphthenic solvents and treatment of the raw stock by such counterflow is conducted by seven separate steps of contact and separation. The naphthenic solvent "Selecto" is a blend of phenol and cresols so proportioned that a high solubility for asphalt is given by the cresols and a critical solution temperature suitable for extraction at normal temperatures is given by the phenol. Propane is employed both as a solvent for the paraffinic fraction and to increase the selectivity of the separation between paraffinic and non-paraffinic fractions. Introduction of the raw stock to an intermediate contacting and separating step permits the removal of the paraffinic layer at the point of introducing the naphthenic solvent and the removal of the naphthenic layer at the point of introducing the paraffinic solvent. Thus the raw stock may be divided into fractions of sharply different characterteristics and contamination of fractions eliminated.

In recent years, solvent dewaxing systems have been developed which are largely replacing the older dewaxing methods because of their great flexibility as to type of stocks handled. The use of this type of dewaxing operation in conjunction with the Duo-Sol process permits extraction and dewaxing operations to be switched together from one type of stock to another so that only limited storage is required between the Duo-Sol and dewaxing operations.

An example of commercial Duo-Sol operation on Osage residuum is as follows:

Charge—	
Gravity A.P.I	20.0
Vis. at 210° F. S.U.S.	351
Flash	590
Raffinate—	
Gravity A.P.I.	28.5
Vis. at 210° F. S.U.S.	136.5
Flash Pensky Martin	520
Color N.P.A.	4½
Yield Vol. %	67.3
Dewaxed Oil—	
Gravity A.P.I.	28.1
Vis. at 210° F. S.U.S.	140.9
Viscosity Index	100
Pour °F.	+5
Color N.P.A.	5
C.R.	.30

Effect of Crude Source on Lubricating Oil Quality

Before the advent of solvent extraction, lubricating oil quality was almost entirely a matter of crude source. Today oils of equal paraffinicity are produced without regard to crude source, although yield of paraffinic oil and resistance to oxidation are greatly affected by crude source. Little is known about this quality of some oils of high viscosity index to be more resistant to oxidation than others but frequently high stability has been found along with high sulphur, which would indicate the presence in some crudes of sulphur type oxidation inhibitors.

Since the high yield stocks do not necessarily produce the most stable oils, it is important that crude sources be investigated with regard to each of these characteristics.

Compressor Losses Caused By Orifice Meters

J. G. BURNHAM and V. E. MIDDLEBROOK
Shell Oil Company, Inc.

THE primary function of an orifice meter is to measure gas. In the majority of cases the meter is set at the boundary of each lease to measure the gas from the field. It is also common practice to set a plant master meter to determine the total incoming volume. This meter has a dual purpose as it not only determines the total volume being processed, but also allows the operator in the plant to obtain some indication of the load from the field. Thus, by a glance at the master meter, the operator will know whether an engine should be shut down or started up. This is a minor use for the meter because the same function could be performed by a recording pressure-vacuum gauge.

It should be evident that, in many instances, the installation of an orifice meter is controlled by habit and past practice, and by following this procedure possible economies are overlooked which could result from correct installation.

In order to illustrate this fact, Table 1 has been computed for a master meter in a 12-inch line with the gas, on the upstream side of the orifice, available at 10.47 pounds absolute, or 8 inches of mercury vacuum. This tabulation has been calculated from fundamental assumptions using data from generally accepted sources such as Diehl's Handbook and the American Meter Company's Bulletin E-2.

In order to clearly define these assumptions, consider that an orifice is inserted in a line carrying gas. A differential, or pressure drop, across the orifice will result, but the reading obtained at the faces of the flange will be higher than that registered at 2½ and 8 pipe diameters from the orifice. The flange tap differential is not a true value but an exaggerated one, whereas the differential at 2½ and 8 pipe diameters represents the actual pressure loss due to the orifice. Accordingly, the net effect of an orifice is to produce a final downstream pressure which is lower than the upstream pressure.

THE effect of an orifice inserted in a line carrying gas will be to produce a final downstream pressure which is lower than the upstream pressure.

In the case of an orifice meter, which is usually installed relatively close to the compressor suction header, the final downstream pressure will be essentially the intake pressure of the machines. If there were no orifice in the line the upstream or higher pressure, not the final downstream pressure, would be the intake to the machines.

If the orifice plate is eliminated one of the following conditions will prevail:

1. The machine will handle more gas due to an increase in volumetric efficiency; or

2. Less horsepower, either total or per million, will be required to boost the same volume to a specified discharge pressure.

For the case given here, of a 12-inch line carrying 3,000 MCF of gas available at 8-inch vacuum, the percent of volumetric capacity lost will range from 1 percent at 5 inches differential to 15 percent at 50 inches. The percent increase in HP/MMCF required to boost to 40 pounds varies from about 1 percent at 5 inches to 11 percent at 50 inches.

If the orifice is removed from the master meter the total incoming gas volume can be determined by two meters; one installed on absorber residue, the other on the stabilizer tops. A factor calculated from a fractional analysis of the finished product may be used to convert the gallons of stabilized gasoline to equivalent cubic feet of gas. The total of the two metered volumes plus the factored volume will equal the volume of gas entering the plant.

This paper was presented before the twentieth annual meeting of the Natural Gasoline Association of America, Dallas, April 25, 1941.

Figure 1 presents the percent of the differential actually lost, measured at flange taps, as a function of the ratio of the orifice diameter to pipe diameter. This shows that for the range of these calculations the percent differential lost will vary from 53 percent at 0.7 to about 76 percent at .43. Figure 2, is merely

TABLE 1

Basis: 12" line
Gas available at 10.47 lbs. absolute
Measuring pressure 14.4 lbs. absolute
Discharging pressure 54.4 lbs. absolute
Specific gravity 1.00

Inches Water Differential Using Flange Taps	Orifice Size Inches	Upstream Pressure lbs./sq. in. Absolute	Downstream Pressure lbs./sq. in. Absolute	Percent of Differential Actually Lost	M. Cubic Feet Handled Per Day	Percent Loss of Volumetric Capacity	HP/MMCF Required to Boost from 10.47 lbs. Absolute to 54.4 lbs. Abs.	Percent Increase In HP/MMCF Required
0	No Orifice	10.47	10.47	0	3,000	0	102.25	0
5	8.388	10.47	10.37	53.00	2,968	1.07	103.00	0.78
10	7.337	10.47	10.25	59.90	2,929	2.38	104.00	1.71
15	6.742	10.47	10.12	64.04	2,886	3.79	105.00	2.69
20	6.331	10.47	9.99	67.05	2,844	5.19	106.00	3.67
25	6.020	10.47	9.85	69.38	2,799	6.71	107.00	4.65
30	5.771	10.47	9.70	71.33	2,750	8.35	108.25	5.87
35	5.566	10.47	9.55	72.92	2,701	9.98	109.55	7.14
40	5.390	10.47	9.40	74.47	2,652	11.59	110.80	8.36
45	5.242	10.47	9.24	75.71	2,600	13.33	112.25	9.78
50	5.106	10.47	9.09	76.83	2,552	14.94	113.65	11.15

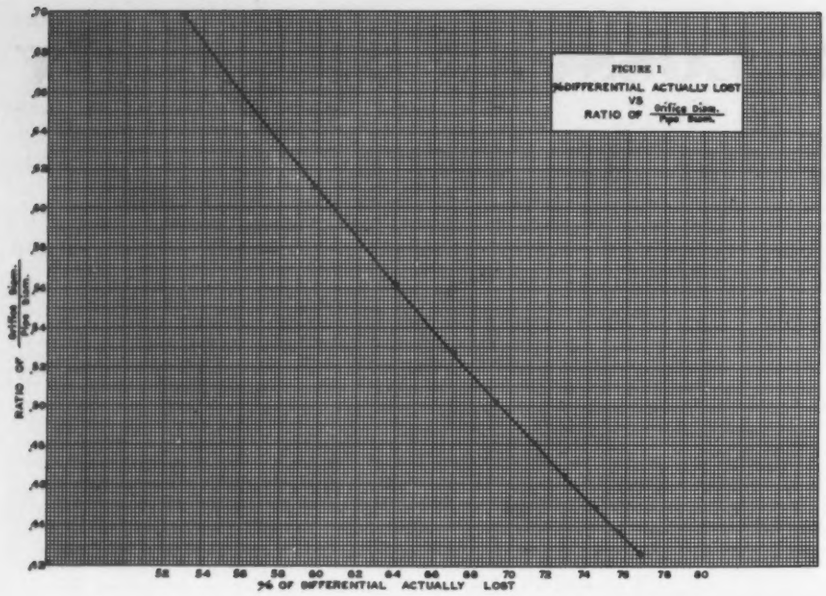
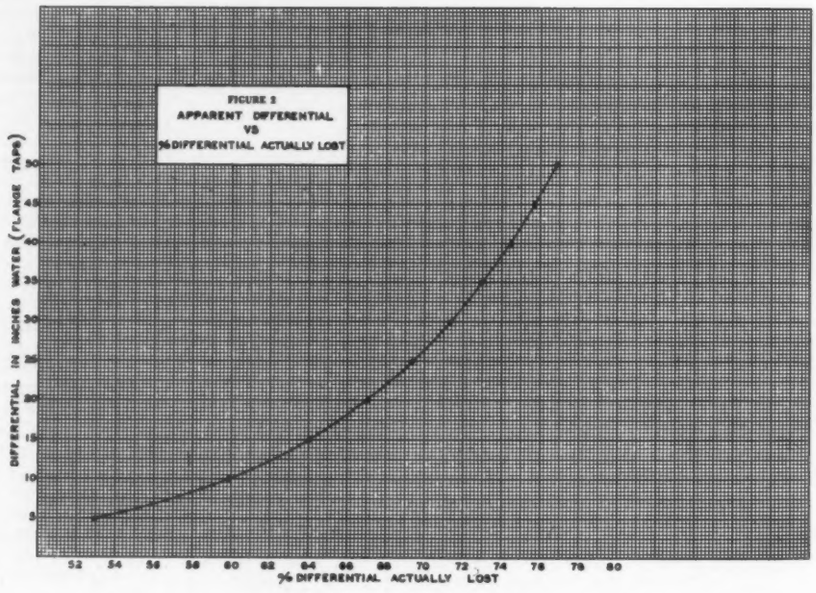


FIGURE 1
% DIFFERENTIAL ACTUALLY LOST
VS
RATIO OF Orifice Diam. / Pipe Diam.
RATIO OF Orifice Diam. / Pipe Diam.
52 54 56 58 60 62 64 66 68 70 72 74 76 78 80
% OF DIFFERENTIAL ACTUALLY LOST



a plot of the same data showing the variation of the flange top differential with the percent differential lost.

In the case of a master meter, which is usually installed relatively close to the compressor suction header, the final downstream pressure will be essentially the intake pressure of the machines. If there were no orifice in the line the upstream or higher pressure, not the final downstream pressure, will be the intake to the machines. Then if the orifice plate be eliminated one of the two following conditions will prevail: (1) the machine will handle more gas due to an increase in volumetric efficiency, or (2) less horsepower, either total or per million, will be required to boost the same volume to a specified discharge pressure. This may be further illustrated by a tabulation taken from Table 1:

	30" Differential	0" Differential	
	1.	2.	3.
Volume—MCF	2750	3000	2750
HP/MMCF	108	102	102
Total Horsepower	298	306	281

Thus it may be seen that, if a 30-inch differential is reduced to 0 inches, by removal of the orifice, Case 2 may result which fulfills the condition that more gas will be handled due to an increased volumetric efficiency, or, Case 3 may result conforming to the assumption that the same volume can be handled with less horsepower.

The percent loss of volumetric capacity of the compressor with increasing differential, registered by flange taps, given in Figure 3, ranges from 1 percent at 5 inches to 15 percent at 50 inches. Figure 4 shows the percent increase in horsepower per million required to boost to 40 pounds with flange tap differentials of 5 to 50 inches.

These two cases meet the conditions that exist in many plants where intake or discharge pressures have changed over the course of time. In other words, since the plant began operation the field conditions may have altered so that the machines are either underloaded or overloaded, which is to say, either the cylinders are too small or the plant is short on horsepower. For example, if the cylinders are up to their handling capacity under fixed conditions of intake and discharge pressure, and an increased volume is made available to the plant, the removal of the orifice would raise the throughput of

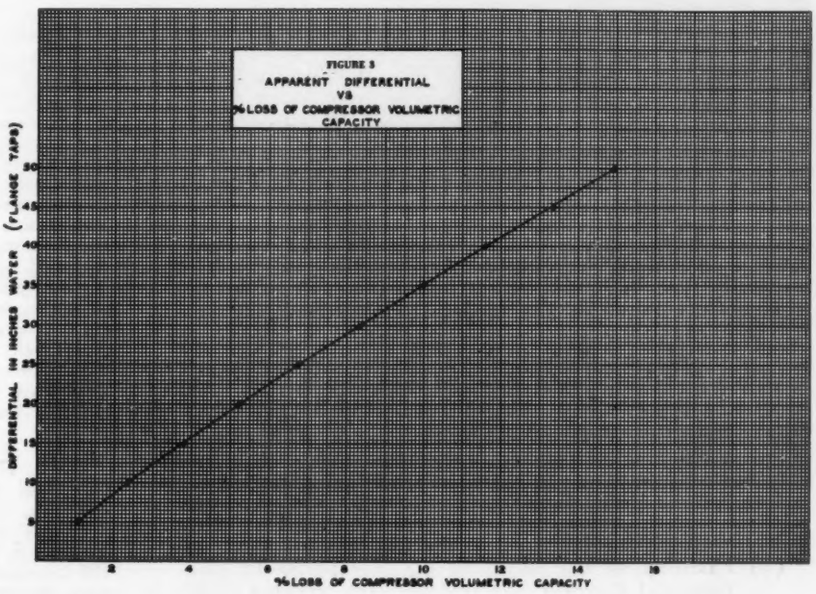
the machines. Also, under the above conditions regarding cylinder capacity, the machines will be operating below their rated horsepower. If the orifice is removed the compression ratio and the corresponding HP/MMCF will be reduced.

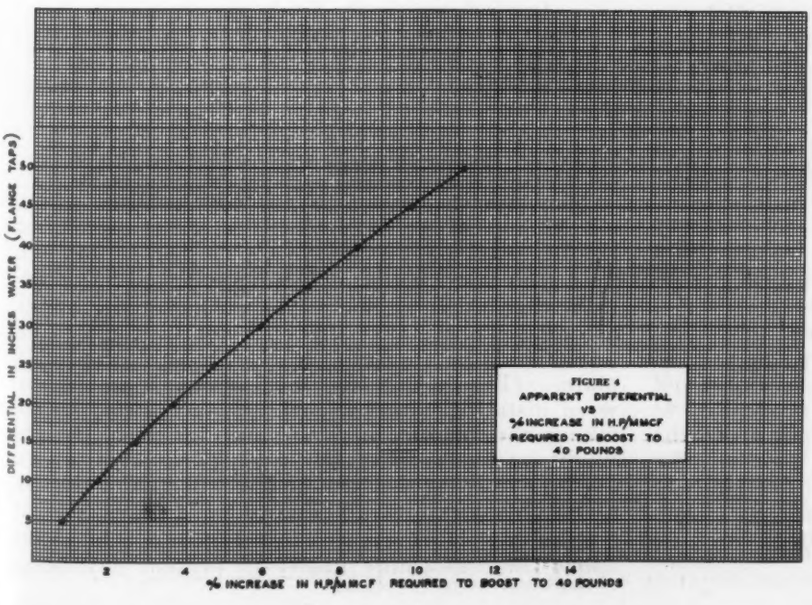
For a plant recently constructed, calculations similar to Table 1, indicated losses of sufficient magnitude to cause our company to eliminate the master meter and to change existing installations.

Obviously, if the master meter is eliminated some other method must be used to determine the incoming gas volume. This volume can be computed from the field meters provided they are equipped with 24-hour clocks, however the volume can be determined with the same accuracy by another method involving two meters. In the majority of plants a meter is installed for measuring the absorber residue, and another may be set for the stabilizer tops. A factor calculated from a fractional analysis of the finished product may be used to convert gallons of stabilized gasoline to equivalent cubic feet of gas. The total of the two metered volumes plus the factored volume will equal the volume of gas entering the plant.

In order to successfully meter the stabilizer tops the line should be steam jacketed to slightly superheat the vapors and the back pressure regulator properly sized to reduce the flow fluctuation which would destroy accuracy of the chart reading. However, even if these precautions are not taken, accuracy within reasonable limitations may be sacrificed in order to gain compressor capacity or horsepower.

The same differential losses across an orifice occur in field meters. Normally, the field operator sets the regulator to maintain constant separator pressure. If the orifice were removed and the separator pressure maintained, the inherent horsepower loss would be eliminated as the same amount of gas would be boosted through a shorter compression ratio. Naturally, field meters cannot be eliminated, but where the flow of gas is relatively constant the orifice can be sized so as to reduce the differential and the corresponding actual pressure loss to a minimum, still allowing accurate reading of the chart. For these cases, the limitations as set by good practice, should be not more than 15 to 20 inches differential and not less than 5 inches.





Performance of Bubble Plate Columns

A Visual Study of Froth Heights in Downspouts and on Bubble Plates

WILLIAM D. HARBERT, EDWARD S. HOMAN,
DURWARD DEVERN ROSEBERY, and R. L. HUNTINGTON
University of Oklahoma

THERE are two principal factors which determine the capacity of a bubble plate column such as a fractionator or an absorber:

1. The maximum quantity of liquid which can be passed downward through the downspout,
2. The maximum quantity of vapor or gas that can be passed upward through the bubble plate.

Both of these maxima are fixed by the limit above which the column will no longer function in a normal manner. These two fluids, that is, the downward-flowing liquid and the upward-flowing vapor, are mutually interdependent upon each other, in so far as their performance in the tower is concerned.

Previous Work

When a bubble plate column is overtaxed, it may be due to the result of one or more of three separate effects as reported by Souders, et al[7]:

"(1) Entrainment or the mechanical carrying of liquid droplets from one tray to another due to inadequate tray spacing or to excessive vapor velocities.[1 to 6]

(2) Priming or the building up of a pressure differential through the bubble caps greater than the equivalent head of liquid between plates.

(3) Flooding or the over-taxing of the liquid capacity of a downspout or weir due to excessive liquid over-flow."

These investigators made a study of the froth heights in a 12 x 24-inch pyrex glass section which was mounted on top of a two-cap bubble tray. The downspout from this tray consisted of a 2-inch nipple in which the nature of the overflow from the tray could be observed. It was found in that investigation that the performance of the downspout depended upon three different types of flow:

"(1) At low heads, operating as a weir;

(2) at intermediate heads, operating as a free-running orifice taking a froth mixture of liquid and vapor, but with sufficient vortex area to allow free separation of the vapor from the liquid; and

(3) at high heads, operating as an orifice running full and with capacity diminished by disengagement of vapor from the froth mixture within the orifice."

THE counter-current flow of air and kerosene has been observed in several plate-to-plate sections of a 12-inch inside diameter bubble-tray tower under a wide range of liquid and gas flow rates. It has been found that the ability of a downspout to disengage vapor from the frothy mixture flowing from the tray above determines in a large measure the gas and liquid capacity of a tower. Froth heights in the downspouts may vary considerably without the occurrence of priming or flooding; however, on the trays themselves, it was seen that once froth began to build up, there was no stopping until the entire plate-to-plate section was filled with a frothy fluid mixture, whereupon the tower ceased to function counter-currently. The behavior of the flow of liquid and froth in the downspout conformed closely to the mechanism described by Souders, et al, in the American Institute of Chemical Engineers Transactions, Vol. 34, pg. 71, 1938.

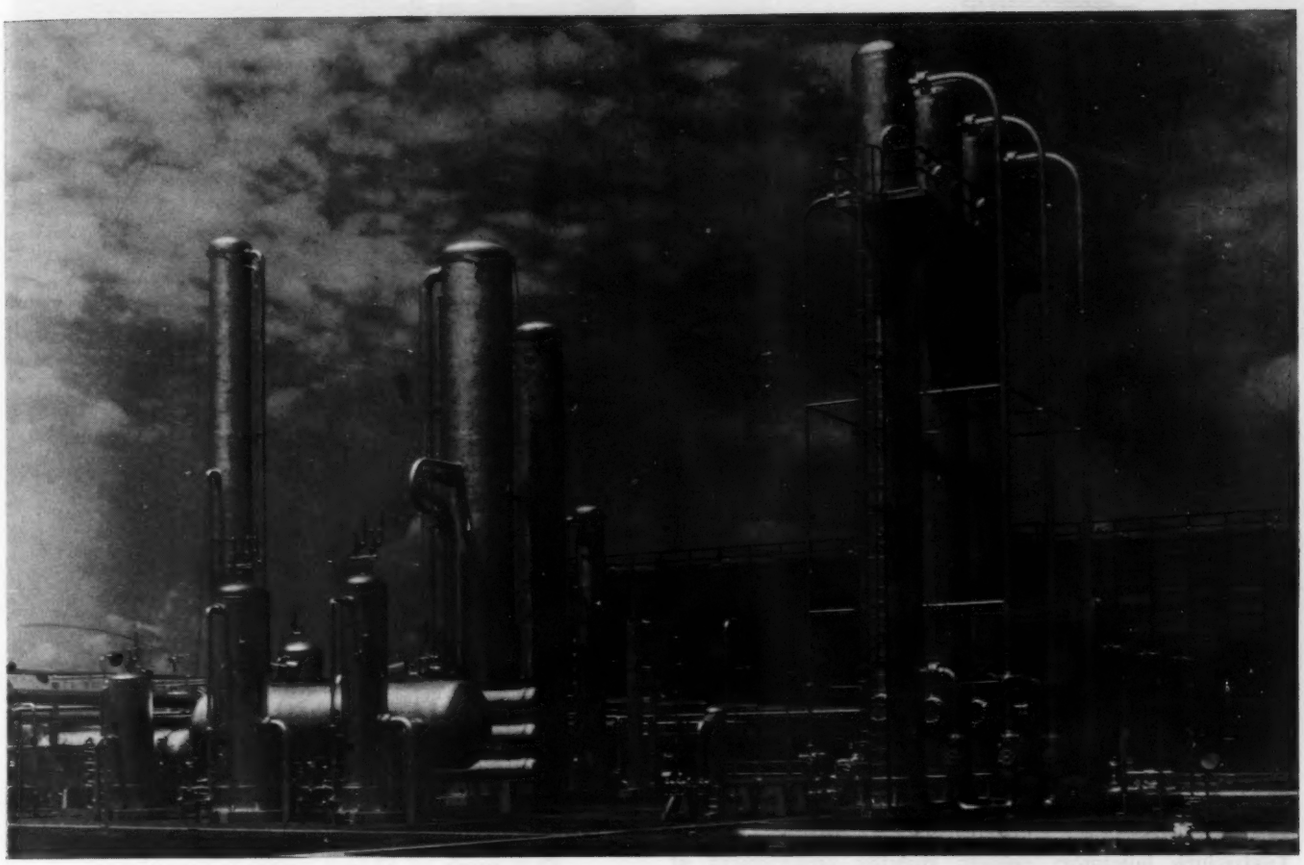
THE AUTHORS

R. L. Huntington is director of the School of Chemical Engineering, University of Oklahoma, Norman, Oklahoma. William D. Harbert is doing graduate work at the University of Michigan. Edward S. Homan is with the Tide Water Associated Oil Company, Drumright, Oklahoma. Durward Devern Rosebery is with Crane Company, Chicago.

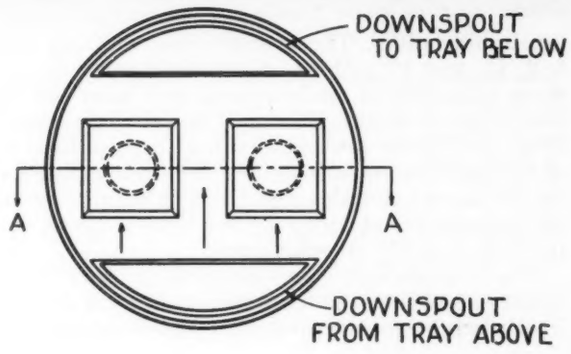
Original data for the article was obtained by the latter three while they were doing undergraduate research in chemical engineering at the University of Oklahoma.

Scope of Present Investigation

The authors have used the same 12-inch column which Souders, et al, employed in the study of froth heights in the twelve-inch pyrex section. In this work pyroxylin windows have been installed at 90° angles from each other at several locations on the 12-inch column in order that the behavior of the gas and liquid could be observed on the surface of the bubble plates. (Figure 1.) Elliptical shaped downspouts were installed with pyroxylin windows on the side facing the bubble plate so that the froth heights might be observed in the downspout itself as well as the nature of the flow of the fluids from the tray above. The location and dimensions of the downspout and bubble plates are shown in Figure 2. This downspout conforms more nearly to present day design



High pressure absorption distillation equipment at a Gulf Coast condensate recovery plant.



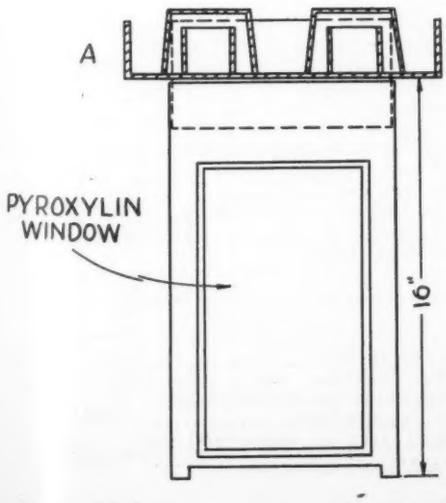


FIGURE 1
Detail of bubble plate with downspout attached.

than the 2-inch pipe which was used in the previous investigation.[7] Then too, the operation of several trays at the same time should give a better idea of the performance of a column than the results which were obtained with a single tray on which the liquid was directly pumped.

The kerosene which was used in this experimental work had a specific gravity of .817 at 80° F., and a viscosity of 1.8 centipoises. It had a surface tension of 30.8 dynes per centimeter. Air was used as the upward flowing gaseous medium.

Experimental Apparatus and Procedure

The laboratory column as shown in Figure 3 permitted the visual observation of conditions existing in the downspout and upon the bubble plates at all times during the runs. The plates and downspouts are numbered from the bottom of the column upward. The spacing between the plates was as follows:

Plate to plate, 1-2, 16 inches; 2-3, 20 inches, and 3-4, 24 inches.

The kerosene, which was circulated by a rotary pump, could be admitted on any one plate. The air supply entered the tower about three feet from the base. The temperature of the circulating kerosene was controlled manually within ± 2° F. by means of a steam coil located in the base of the column. The differential and overall pressures were measured by means of water manometers, and orifice meters served to record the liquid and air rates of flow.

Discussion of Results

The original data are shown in Table 1, and Figures 4 to 9 inclusive, the runs having been grouped according to the kerosene flow rate over the

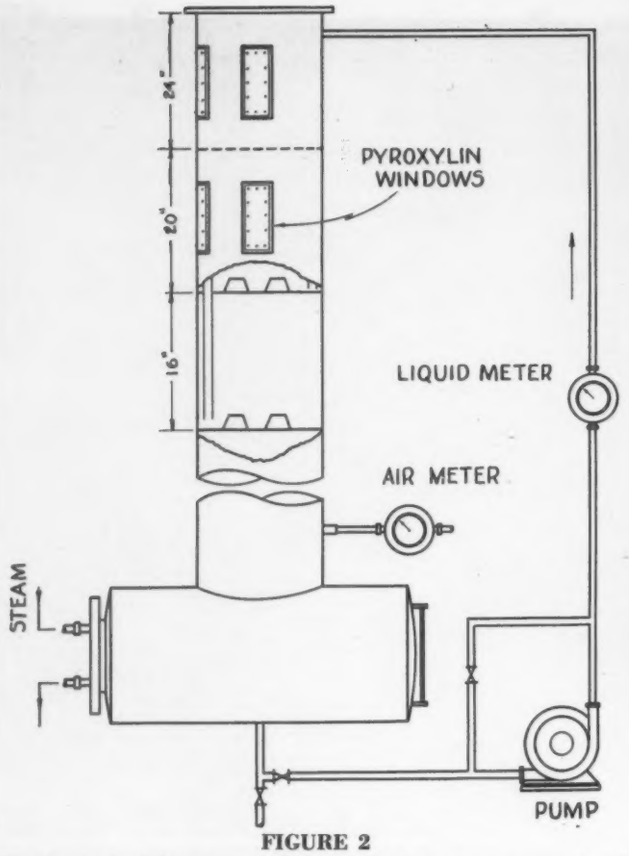


FIGURE 2

Twelve-inch laboratory column showing arrangement of bubble plate and downspout.

FIGURE 3

Photograph of 12-inch bubble plate column.

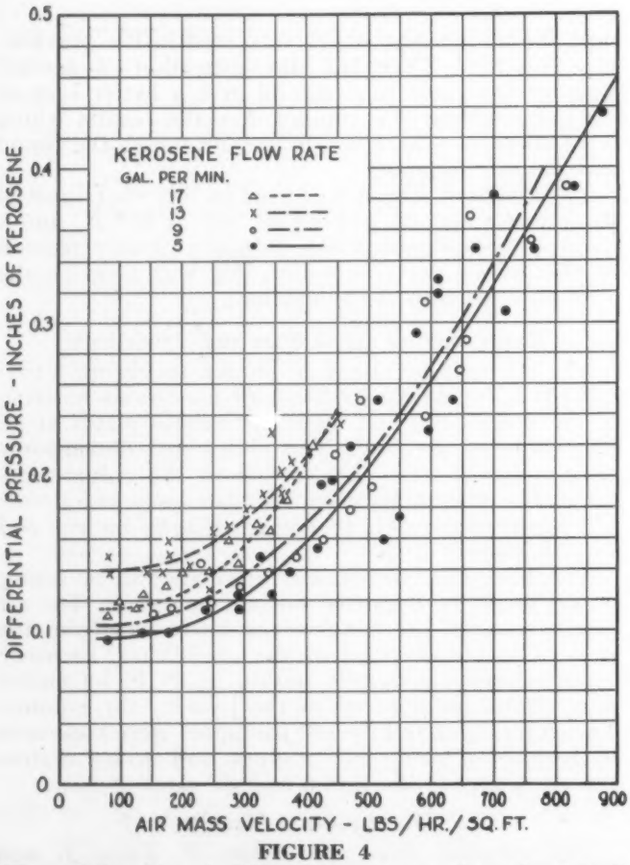


FIGURE 4

The relationship of differential pressure through plate 1 versus air-mass velocity for different kerosene flow rates.

top bubble plate. These flow rates were as follows: 5, 9, 13, and 17 gallons of kerosene per minute. The mass velocities of air in pounds per hour per square foot of cross-sectional area of the tower varied from 75 up to 875 for the runs having the low liquid rates of five gallons per minute. At the higher liquid rates, the air mass velocities could not be maintained above 450 pounds per square foot per hour without causing the tower to fill up with froth.

The data included pressure differentials from tray to tray as well as the froth height in each downspout. Froth heights on the trays proved to be almost con-

Tower and Plate Dimensions

Inner diameter of tower, inches	12.5
Number of chimneys in plate	2
Chimney (round in shape)	
Inner diameter, inches	1.75
Outer diameter, inches	1.844
Height from bottom of plate, inches	2.25
Ratio, cross sectional area of chimneys to that of tower	0.0394
Bubble Caps (square in shape)	
Number of caps per tray	2
Outer dimensions of each cap, top, inches	3.25 x 3.25
Outer dimensions of each cap, bottom, inches	3.75 x 3.75
Thickness of metal, inches	.0625
Number of slots in each cap	32
Length of each slot, inches	1.0
Width of each slot, inches	0.375
Downspout (Half moon in shape)	
Length	
No. 1, inches	16
No. 2, inches	20
No. 3, inches	24
Bottom width, outside, inches	9
Bottom width, inside, inches	8.5
Height of downspout above top of plate, inches	0.5
Cross-sectional area, square feet	0.082
Ratio, cross-sectional area of downspout to that of tower	0.0955

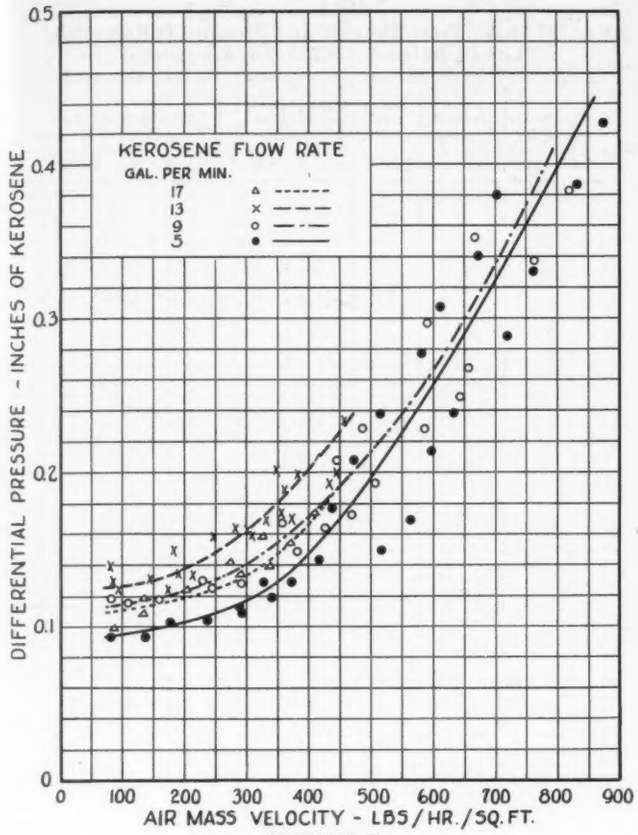


FIGURE 5

Differential pressure through plate 2 versus air-mass velocity for several kerosene flow rates.

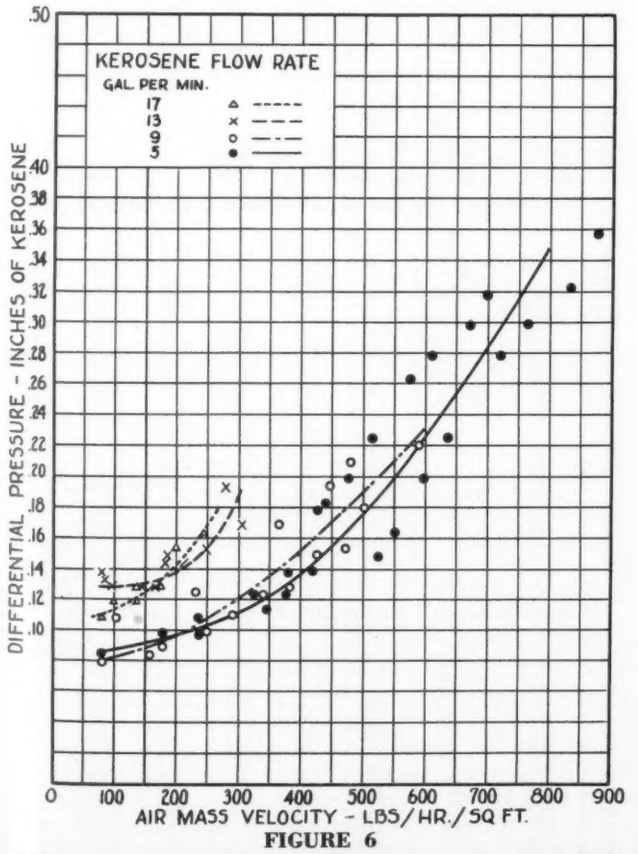


FIGURE 6

Differential pressure through plate 3 versus air-mass velocity for several kerosene flow rates.

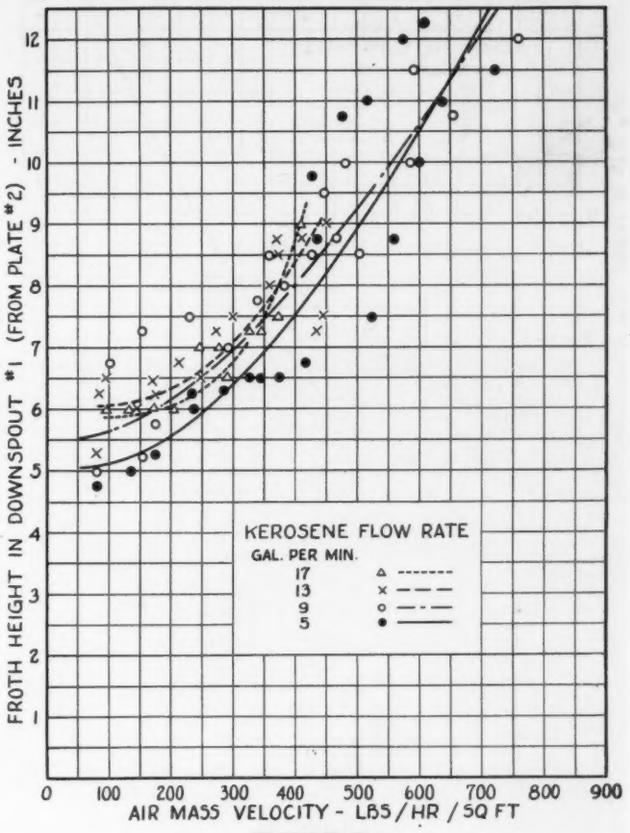


FIGURE 7

Froth height in downspout above tray No. 1 versus air-mass velocity for several kerosene flow rates.

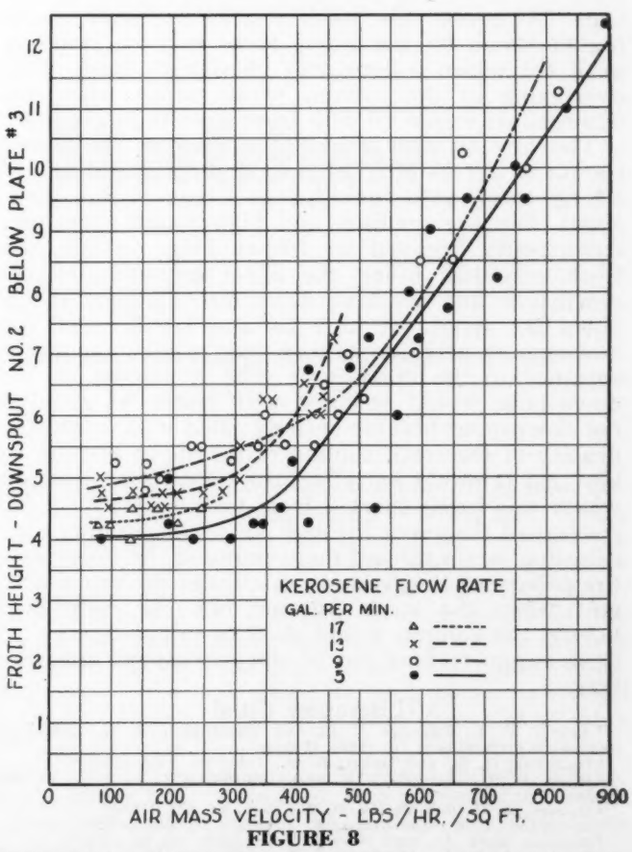


FIGURE 8

Froth height in downspout above tray No. 2 versus air-mass velocity for several kerosene flow rates.

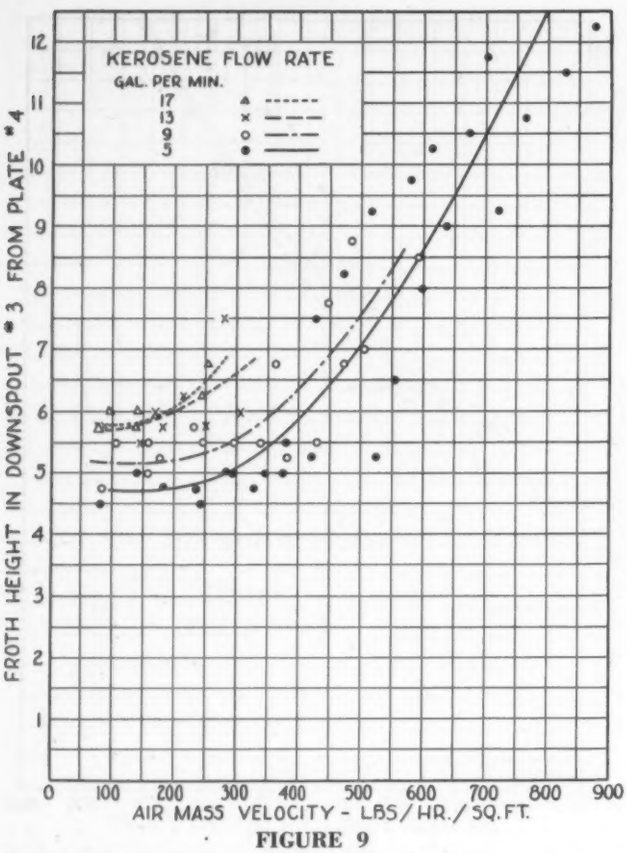


FIGURE 9

Froth height in downspout above tray No. 3 versus air-mass velocity for several kerosene flow rates.

sistent at an inch or two above the tops of the bubble caps. Whenever the froth started to build up to higher levels on the trays, there was no stopping until the entire colume was filled with froth. This overtaxing of the column would occur when the downspouts would fill with froth from top to bottom.

The low air and liquid rates caused the downspouts to act as weirs, the froth breaking down to a large extent into liquid before it entered the downspout. For the medium and high liquid rates, the downspouts behaved as free-running orifices, the froth only half filling the upper entrances to the downspout and breaking down into liquid as it ran down the spout. At high air and liquid rates, the downspouts acted as orifices only at the mouth or entrance to the downspout. The remainder of the downspout would be filled with froth. As soon as the downspout became entirely filled with froth, the density of the froth column in the spout became so low that it would not offset the differential pressure which was being exerted from plate to plate by the passage of the vapor through the plate. Another contributing factor toward the priming of the tower was the failure of the froth to disengage its vapor content when the spout became full. As mentioned before, the column would start to prime as soon as froth began to feed out of the downspout onto the tray.

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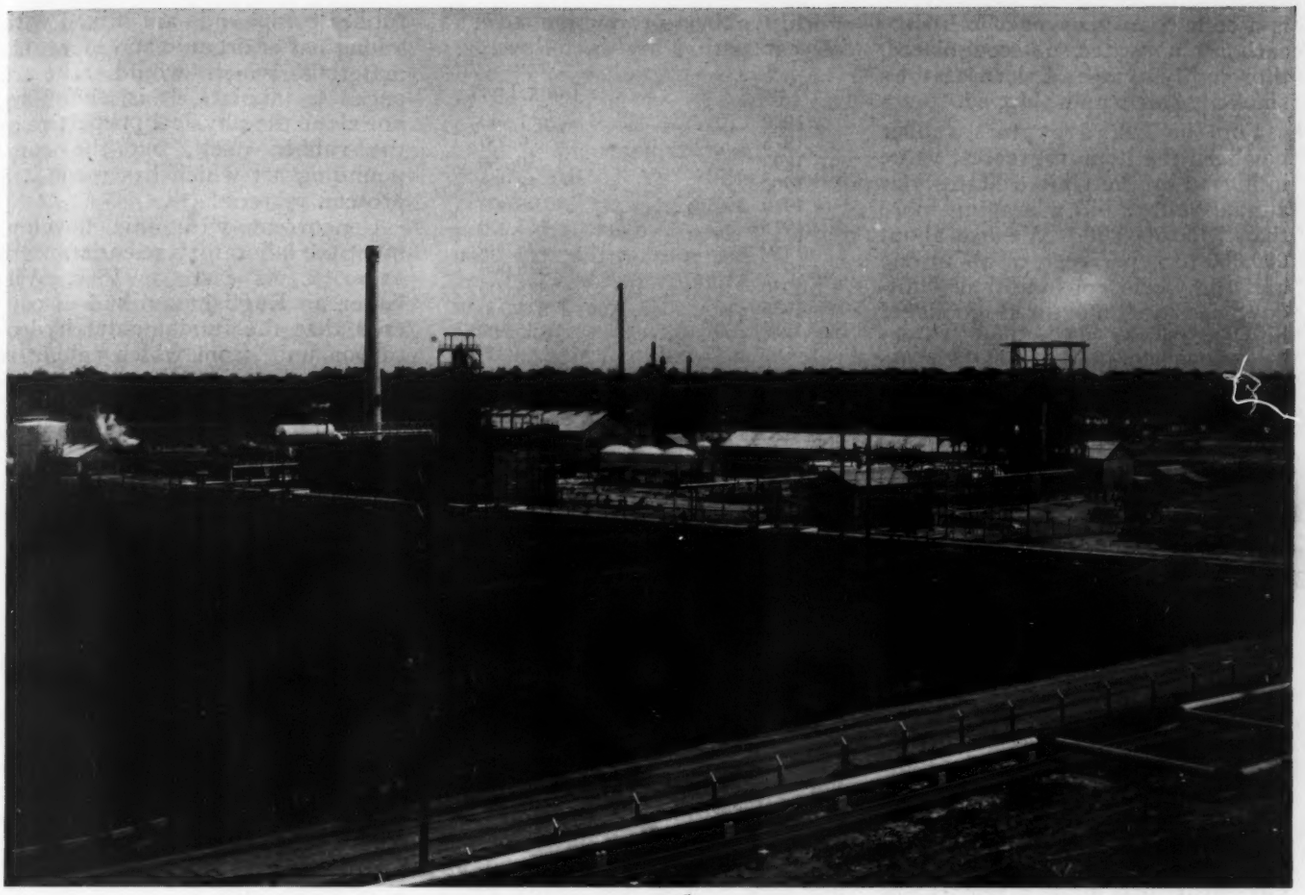
TABLE 1

Original Data: Froth Heights and Pressure Differentials
Liquid Rate—5 Gallons of Kerosene

Run No.	Air Mass Velocity Lbs./Hr./Sq. Ft.	Overall Pressure Drop, Ft. Kerosene	Differential Pressure Drop Across Plate, Ft. of Kerosene			Froth Height in Downspout, Inches		
			No. 1	No. 2	No. 3	No. 1	No. 2	No. 3
37	81	.353	.094	.088	.084	4.75	4.00	4.50
38	137	.373	.099	.094	.089	5.00	4.00	5.00
39	176	.383	.099	.099	.094	5.25	4.00	4.75
61	176	.318	.099	.104	.094	6.00	5.00	*
62	178	.398	.099	.104	.099	6.00	4.25	4.75
63	234	.432	.109	.109	.109	6.25	4.00	4.75
40	239	.417	.114	.104	.099	6.00	4.00	4.50
64	288	.477	.124	.114	.109	6.25	4.25	5.00
41	292	.437	.114	.109	.109	6.25	4.00	5.00
65	326	.542	.149	.129	.124	6.50	4.25	4.75
42	344	.467	.124	.119	.114	6.50	4.25	5.00
43	374	.502	.139	.129	.124	6.50	4.50	5 00
66	381	.621	.164	.154	.139	8.00	5.25	5.50
44	418	.557	.154	.744	.139	6.75	4.25	5.25
70	427	.741	.194	.189	.179	9.75	7.00	7.50
69	438	.736	.199	.189	.184	8.75	6.75	7.75
71	471	.815	.219	.209	.199	10.25	7.00	8.25
72	515	.935	.249	.239	.224	11.00	7.50	9.25
45	523	.616	.159	.149	.149	7.25	4.50	5.25
46	553	.666	.174	.169	.164	8.75	6.25	6.50
73	577	1.048	.293	.278	.263	12.00	8.25	9.75
50	597	.850	.229	.214	.119	10.00	7.25	8.00
74	611	1.193	.323	.308	.278	12.25	9.00	10.25
49	634	.940	.249	.239	.224	11.00	7.75	9.00
75	671	1.283	.348	.343	.298	12.75	9.50	10.50
76	701	1.417	.378	.383	.318	*	10.50	11.50
48	720	1.148	.308	.298	.278	11.50	8.25	9.25
51	763	1.268	.348	.333	.298	12.75	9.50	10.75
52	828	1.457	.388	.383	.323	*	11.00	11.50
53	875	1.610	.437	.427	.358	*	12.50	12.25
54	920	1.760	.467	.472	.388	*	14.25	13.50
Liquid Rate—9 Gallons of Kerosene Per Minute								
27	82	.388	.104	.119	.080	5.00	4.25	4.75
84	101	.437	.119	.114	.109	6.75	5.25	5.50
28	155	.413	.109	.119	.084	5.25	4.75	5.00
85	163	.472	.129	.119	.119	7.25	5.50	5.50
29	175	.429	.114	.124	.089	5.75	5.00	5.25
86	230	.522	.144	.129	.124	7.50	5.50	5.75
30	246	.452	.119	.125	.099	6.50	5.50	5.50
31	292	.492	.129	.129	.109	7.00	5.25	5.50
32	338	.527	.139	.139	.124	7.75	5.50	5.50
82	359	.686	.184	.169	.169	8.50	6.00	6.75
33	382	.567	.149	.149	.129	8.00	5.50	5.25
34	427	.616	.159	.159	.149	8.50	5.50	5.50
79	448	.795	.214	.199	.194	9.50	6.50	7.75
35	468	.676	.179	.174	.154	8.75	6.00	6.75
78	481	.900	.249	.229	.219	10.00	7.25	8.75
55	503	.731	.194	.194	.179	8.50	6.25	7.00
56	589	.885	.239	.229	.219	10.00	7.00	8.50
80	591	*	.313	.298	*	11.50	9.50	*
58	652	*	.288	.268	*	10.75	8.50	*
81	666	*	.368	.353	*	12.50	10.75	*
59	761	*	.353	.338	*	12.00	10.50	*
60	820	*	.388	.383	*	*	11.25	*
Liquid Rate—13 Gallons of Kerosene Per Minute								
2	82	.537	.149	.139	.139	5.25	5.00	5.75
6	85	.532	.139	.129	.134	6.25	4.75	5.75
87	97	.502	.139	.124	.129	6.50	4.50	6.00
4	144	.557	.139	.129	.129	6.00	4.75	5.50
88	169	.537	.139	.124	.129	6.50	4.50	6.00
5	180	.567	.149	.134	.144	6.25	4.50	5.75
3	183	.576	.159	.149	.149	5.75	4.75	5.75
89	213	.562	.144	.134	.144	6.75	4.75	6.25
7	249	.606	.164	.159	.154	6.50	4.75	5.75
90	279	.641	.169	.164	.194	7.25	4.75	7.50
8	304	.656	.179	.164	.164	6.75	5.00	6.00
91	310	*	.174	.159	*	7.50	5.50	*
99	346	*	.229	.209	*	8.75	6.50	*
11	360	*	.204	.189	*	8.00	6.25	*
96	361	*	.189	.169	*	7.50	5.50	*
97	372	*	.199	.179	*	8.00	6.00	*
98	373	*	.219	.199	*	8.50	6.75	*
12	413	*	.219	.209	*	8.75	6.50	*
14	435	*	.184	.164	*	7.25	5.50	*
15	443	*	.189	.169	*	7.50	5.75	*
13	453	*	.234	.224	*	9.00	7.25	*
Liquid Rate—17 Gallons of Kerosene Per Minute								
16	81	.437	.109	.099	.109	5.25	4.25	5.75
101	98	.447	.119	.114	.119	6.00	4.00	6.00
17	135	.462	.114	.109	.129	6.00	4.50	5.75
102	137	.477	.124	.119	.119	6.00	4.00	6.00
18	174	.482	.129	.119	.129	6.00	4.50	6.00
103	202	.437	.139	.124	.154	6.00	4.00	6.75
19	245	.562	.139	.129	.164	7.00	4.50	6.25
106	273	*	.159	.144	*	7.00	5.25	*
20	289	*	.144	.134	*	6.50	5.50	*
107	326	*	.169	.169	*	7.50	6.00	*
21	337	*	.164	.139	*	7.25	5.75	*
22	369	*	.184	.154	*	7.50	6.00	*
23	410	*	.219	.174	*	9.00	5.75	*

* Means no data available.



Chemical Products Division of the Standard Oil Company of Louisiana at Baton Rouge.

Synthetic Rubber

J. E. LIGHTBOWN and J. A. BRITTON, JR.
Standard Oil Development Company

Before the annual meeting of the Western Petroleum Refiners Association, Hot Springs, Arkansas, April 16, 17 and 18

CERTAIN tropical and semi-tropical trees and shrubs yield a white liquid of milk-like appearance which we have consequently called latex. It should not be confused with sap, for it is a separate tree liquid existing in one of the inner bark layers and not in the wood or main body of the tree. When this milk-like liquid is evaporated or coagulated we find that we have rubber. Although the most common source is the Hevea brabiliensis, latex may be found in a great many other plants. But these sources are relatively unimportant commercially, so that the Hevea may be considered as the real "rubber tree." So much so, in fact, that it was taken 10,000 miles from its native home, in the Amazon Valley, to the islands of Southeastern Asia, where the climate is more suitable and the location more accessible to shipping.

Whatever may be the tree's purpose in bearing latex, it has not been revealed to man. There is a divergence of botanical opinion but it is generally supposed that latex acts either as a food storage reservoir or as a means of discouraging insect pests and parasites from biting or boring into the tree. Along with the latter purpose the latex similarly heals and seals from air any wounds inflicted on the bark.

Contrary to popular belief the latex does not squirt from the tree like water from the fabulous stone. A single tapping of an individual tree yields about a cupful of latex of which only 30-35 percent is rubber. By working rapidly an experienced tree tapper can collect almost 25 pounds of rubber per day.

After collection, the latex, which

is a colloid suspension of a hydrocarbon in water, is coagulated, thoroughly washed, sometimes smoked, baled and shipped.

For the last five years rubber has been the item of greatest value imported by the United States, our annual rubber bill averaging more than $150,000.000.* We use about 600,000 tons per year, or about one half the world consumption. United States manufactured goods of finished rubber are valued at over $1,000,000,000 annually.

One reason why rubber has become one of our most important materials of construction is because of its very great elasticity. That is, it can be greatly deformed but almost immediately return to its original shape as soon as the deforming pressure is released.

Another reason is that rubber can be vulcanized.

Although the substance rubber had been recognized since the time of Columbus and had been used to make waterproof garments and the like during the early days of the Nineteenth Century, it was not until 1839 that the true value of rubber was dimly seen. For in that year the Yanke inventor, Charles Goodyear, had made a remarkable discovery. He had found that by heating mixtures of rubber and sulphur he could produce a new and remarkable material. This process he called vulcanization.

The trouble with unvulcanized rubber was that the suspenders made from it stuck to your shirt on a hot day, while the raincoats made by the Scotsman MacIntosh were as stiff as casket boards during the cold winter months. Charles Goodyear's rubber was quite different. It was as good in summer as in spring and as good in winter as in autumn. In modern language we would say that vulcanization had overcome thermoplasticity. It had done other things as well, for the strength of the rubber was very greatly increased, and it was no longer soluble in hydrocarbons.

From 1839 until the turn of the century progress was slow. New machinery had to be devised, new markets discovered, new processes worked out. But the progress though slow was inevitable. And, with the coming of the automobile, with its pneumatic tires, rubber became one of the world's important structural materials. To illustrate this progress, examples of the world rubber production over a 77-year period are as follows:

Year	Long Tons
1860	1,500
1875	9,000
1890	30,750
1900	48,000
1910	95,000
1915	155,000
1920	295,000
1925	525,000
1930	825,000
1935	873,000
1937	1,135,000

Another reason for rubber's boldly entering the structural scene, otherwise occupied by inorganic materials such as steel and ceramics, is its marvelous versatility. For rubber can be made into elastic bands, automobile tires, battery boxes, pipe stems, fire hose, motor mountings, sound deadeners, footballs, and a thousand other useful materials which we see almost every day. In the list catalogued above, there is hardy any overlapping of properties. For instance, an elastic band is no more like a battery box than water is like sand, yet they are both made from the same material. If you made an automobile tire from the same rubber compound that you used for fire hose you would hardly get a hundred miles before your tires were completely destroyed. There is no connection whatever between a rubber engine mounting which damps vibration and a fire hose which holds water, except that they are made from the same material. That they are made from the same material and yet fulfill such disparate functions is purely fortuitous. Every day new uses are being found for rubber. In the ordinary automobile alone there are more than 30 pounds of rubber, exclusive of tires.

The compounding of rubber for these divers uses has become a highly skilled art and is at present somewhat analogous to the alloying of iron with other metals to make anything from a pot stove to a battleship. A great many other ingredients besides rubber are used in this compounding art. For example, an automobile tire contains, as well as rubber, zinc oxide, sulphur, complicated organic materials such as morcaptobenzol-thiazol, whiting, stoaric acid, pine tar, cotton or rayon fabric, and carbon black. The carbon black is made by burning natural gas and collecting the soot so obtained to impart good abrasion resistance to the tire, and this carbon black must be submicroscopic in size. Likewise, other rubber compounds are mixed with a long list of organic and inorganic materials which would take 20 pages to tabulate. It is, therefore, not alone the physical properties of the rubber itself, but the compounding art which has made it a protean material.

Concurrent with this development the laboratory scientists were at work. As early as 1860, Williams, an Englishman, had discovered that the fundamental hydrocarbon unit, from which rubber is made, was a new organic compound which he called "isoprene." We know this material today as one of the simpler members of the diolefine family, that is, one of the members of the hydrocarbon family having two double bonds. The structure of isoprene is:

$$CH_2 = C(CH_3)-CH = CH_2$$

For the next 40 or more years the work of chemists was directed toward what could most accurately be called rubber synthesis. At first, the isoprene which Williams had identified was distilled from natural rubber, then it was induced to form rubber again. Since the rubbery material thus produced was of inferior quality and was moreover made from natural rubber itself at considerable cost and time, it could hardly be called commercially feasible, but should rather be classed along with such remarkable but uninteresting chemical processes as making lead out of gold. But in 1884, Sir William Tilden showed that isoprene could be first gotten from turpentine then polymerized into rubber. This was the first real synthetic rubber. To be precise, it was not, of course, a true rubber synthesis, for that operation would mean the exact duplication of all the chemical, physical and structural properties of the natural product, hidden and manifest. But no such rubber ever has been synthetized. And although artificial rubber would be a more accurate name, synthetic rubber is almost universally used.

In about 1900, synthetic rubber investigation entered a new phase. Instead of working only with isoprene, different and more readily available diolefines were studied. Thus it was found that butadiene

$$(CH_2 = CH-CH = CH_2)$$

which is isoprene minus a methyl group, and dimethyl butadiene

$$(CH_2-C(CH_3) = C(CH_3)-CH_2)$$

which is isoprene plus a methyl group could be made into fairly

* United States Department of Commerce—"Rubber: History, Production and Manufacture."

serviceable rubbers by heating them in the presence of sodium. Because butadiene and sodium were used the rubber so formed was called "Buna"—"Bu" from the former and "Na" from the latter (Natrium).

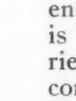
But even with these rubbers the desire had been to duplicate natural rubber as closely as possible. And it was not until the 1920's that it became apparent that a better method would be to duplicate nature's product in some respect but excel it in others. Thus it would be possible, for example, to make the new synthetic rubber last longer, or stand up against oil, or be carried to a higher temperature than natural rubber without melting. Thus, too, it would be possible to sell the new rubber for a higher price; for the Far Eastern plantations were learning newer ways of planting and grafting, so that the yields per acre of natural rubber were higher and the cost of producing lower.

In 1926, the combined work of Nieuwland and Carothers gave us Duprene, since rechristened neoprene. This is made by polymerizing chloroprene

$$(CH_2=\underset{Cl}{C}-\underset{H}{C}=CH_2)$$

which is isoprene with a chlorine atom replacing the methyl group. Before the 1914-18 war the use of such a material for rubber manufacture would have been preposterous. Natural rubber contained no chlorine, so why should synthetic rubber!

At about the same time a not dissimlar type of work was going on in Germany. It had been found that the older method of polymerizing butadiene in the presence of sodium was unsatisfactory. A newer method was devised. It was discovered that when certain modifying agents were added to the butadiene, and a somewhat different method of polymerization was used, a new and greatly superior rubber resulted. The two modifying agents found to be most satisfactory were styrene

$(CH_2=CH-$  $-$ vinyl benzene),

and acrylo nitrile

$(CH_2=CH-CN$ — vinyl cyanide).

When the former is mixed with butadiene, emulsified in water along with the diolefine, and treated with a catalyst, a highly satisfactory rubber substitute results. This is called "Buna S." It is understood that it is this styrene-butadiene rubber that is being used for automobile tire treads in Germany today. If acrylo nitrile is used in place of styrene an even more satisfactory rubber called "Perbunan" can be made. For it is found that such a rubber, unlike natural rubber, does not swell to any marked degree when it comes in contact with oil. This makes it admirably suited to use in seals and gaskets, diaphragms, printer's rollers, gasoline hose and the like.

A few years ago all curb pump hose was made with a flexible metal lining. Between this metal lining and a tight outside cotton braid rubber was inserted. This natural rubber, although it swelled when gasoline came in contact with it, was prevented, by the inside metal lining and the outside braid, from swelling excessively. A hose made in this way was serviceable but not always satisfactory. At that time, too, there was much talk about "oil-resistant" rubber. But this is a contradiction in terms. It is as impossible to make an oil-resistant rubber as it is to make a water-insoluble sugar. If you put enough sand in your sugar and stir a pound of this mixture into a quart of water you will have less sugar dissolved in water than if you had used the same amount of sand-free sugar. To make an "oil-resistant" natural rubber, the rubber compounder followed much the same procedure. That is to say, he mixed a great deal of fillers, such as whiting, clay, or carbon black, in with his rubber and by thus decreasing the amount of rubber per cubic inch of compound he consequently increased the oil-resistance.

With the commercialization of the truly oil-resistant synthetics such as Neoprene and Perbunan, the picture was greatly changed. Since these rubbers were not affected by oil it was now possible to leave the flexible metal lining out of curb pump hose construction entirely so that now almost all hose is the so-called smooth-bore variety where the synthetic rubber comes directly in contact with the fluid but is not swelled or disintegrated by it. Likewise, fuel-oil hose, distillate hose, dock and cargo hose, et cetera, are made from synthetic rubber, as are also the feul and oil lines and the many rubber parts that go into aeroplanes.

Besides its lack of oil resistance, natural rubber suffers other major shortcomings. We have seen that nature's product is made up of a great many isoprene units. We have seen, too, that each of these units contains two double bonds (a diolefine). When isoprene (or indeed any of the othe monomers that go into making the synthetic rubbers so far looked at) is polymerized, it links up with itself, head to tail, like circus elephants in a street parade, to form a very long straight polymer chain. One double bond of each monomer, therefore, is saturated by this linking-up process. But this leaves the other double bond still active in each of the fundamental units. A section of a rubber molecule, therefore, may look like this:

$$(-CH_2-\overset{CH_3}{\overset{|}{C}}=CH-CH_2-CH_2-\overset{CH_3}{\overset{|}{C}}=CH-CH_2-)\,x$$

It will be seen that there is one double bond for each C5 unit, or, if the polymer had butadiene as a starting material, one double bond for each C4 unit. The present theory is that the sulphur of vulcanization links the molecules of rubber together through the double bonds. But, for the very best vulcanized rubber, as little as one to three percent of sulphur is needed. What does this mean? It means that even in vulcanized rubber only a very few of the double bonds present in the molecule are saturated by sulphur. It follows then that a great many of the double bonds are still active, for it has been calculated that as little as two percent of the unsaturation is consumed during vulcanization. The remaining double bonds are still active. They may be fairly readily oxidized; it is because of oxidation that the rubber bands that lie on your desk for a year become hard and brittle. Likewise, to oxidation may be attributed the failure of your two-year-old spare tire to stand up as well as a new tire, although both tires were equally good to start with. By the same token, the ozone formed in the corona around a high-tension power cable or an ignition wire rapidly attacks and disintegrates the rubber insulation. Similarly, acids and strong chemicals readily corrode rubber because there are so many double bonds where they may focus their action.

A few years ago some of the chemists of the Esso Laboratories began thinking about synthetic rubber from a highly unorthodox

point of view. They reasoned that, since only two percent of the unsaturation of natural rubber was used up in the vulcanization process, perhaps only two percent of unsaturation was necessary, the additional double bonds acting only as a kind of undesirable excess baggage. When it is realized that for many years chemists thought that the residual double bonds were responsible for rubber's elasticity it will be seen how radical was this reasoning.

Working along this line these chemists turned to the simple olefines rather than to the previously used diolefines as the fundamental raw material. Along with the olefine a small amount of diolefine was used, the latter only in sufficient quantity to give what was considered the minimum unsaturation to permit the necessary vulcanizability.

If the use of chloroprene as a synthetic rubber constituent had been preposterous to the pre-World War I chemist, such an approach as this would have been inconceivable. But call it what you will, inconceivable or preposterous or whatever else, the fact is that it worked; a rubber was produced that had only about one one-hundreth the unsaturation of natural rubber and yet which vulcanized. Such a rubber, after vulcanization, is substantially saturated. It possesses no double bonds to be oxidized, ozonized, or attacked by acids; it has the chemical stability of a paraffin hydrocarbon.

This type of rubber is now known as butyl rubber. The designation butyl rubber must be considered a generic term, for by varying the type of olefine or diolefine, it is possible to obtain rubbers that differ considerably in their detailed properties, even though they are the same insofar as their limited unsaturation is concerned.

It is not permissible to discuss the polymerization technique at this time, but anyone familiar with hydrocarbon chemistry will realize the economic advantage of utilizing largely a simple olefine, rather than a diolefine, as the raw material for this new synthetic rubber.

Classification of Synthetic Rubbers

If ability to vulcanize with sulphur is taken as a criterion for a true rubber-like material, the known products may be classified as representing four basic types from the standpoint of the nature of the polymer chain, and also from the standpoint of the characteristic physical and chemical properties—viz.:

Starting Point	Products
1. Diolefine	Natural rubber (isoprene) Buna (butadiene) Methyl rubber (dimethylbutadiene) Russian products—SKA, SKB (butadiene)
2. Chloroprene (possibly also with modifiers)	Neoprene Sovprene
3. Diolefines plus modifiers	Buna S (butadiene plus styrene) Perbunan or Buna N (butadiene plus acrylo nitrile) It has been announced that some of the more recent rubbers such as Hycar and Chemigum are butadiene rubbers with modifiers, so it may be assumed that they fit into this classification.
4. Olefines plus diolefines	Butyl rubber

Thiokol is probably the only product usually classified as a synthetic rubber that does not fit into this classification. As a condensation product of chlorine-containing organic compounds and sodium polysulfide, it does not—like the diene polymers — undergo curing with sulphur.

Emergency Situation

Our present annual consumption of crude rubber is about 600,000 long tons. In 1940 it was 777,740 tons, highest in history. Of this, more than 97 percent comes from the Far East, some 10,000 miles away. It cannot be stated authoritatively exactly how much rubber we have on hand, how much is afloat, and what are the quantities of manufactured goods in our warehouses. But it may be assumed that there is a substantial quantity in all these categories.

Under normal conditions, with the synthetic rubber industry selling its products on a quality basis, expectations would be that the synthetics would occupy only a small percentage of the total rubber consumption until an ever-increasing volume permitted a steady decrease in price, and the time when both output and price were in the neighborhood of those figures for rubber.

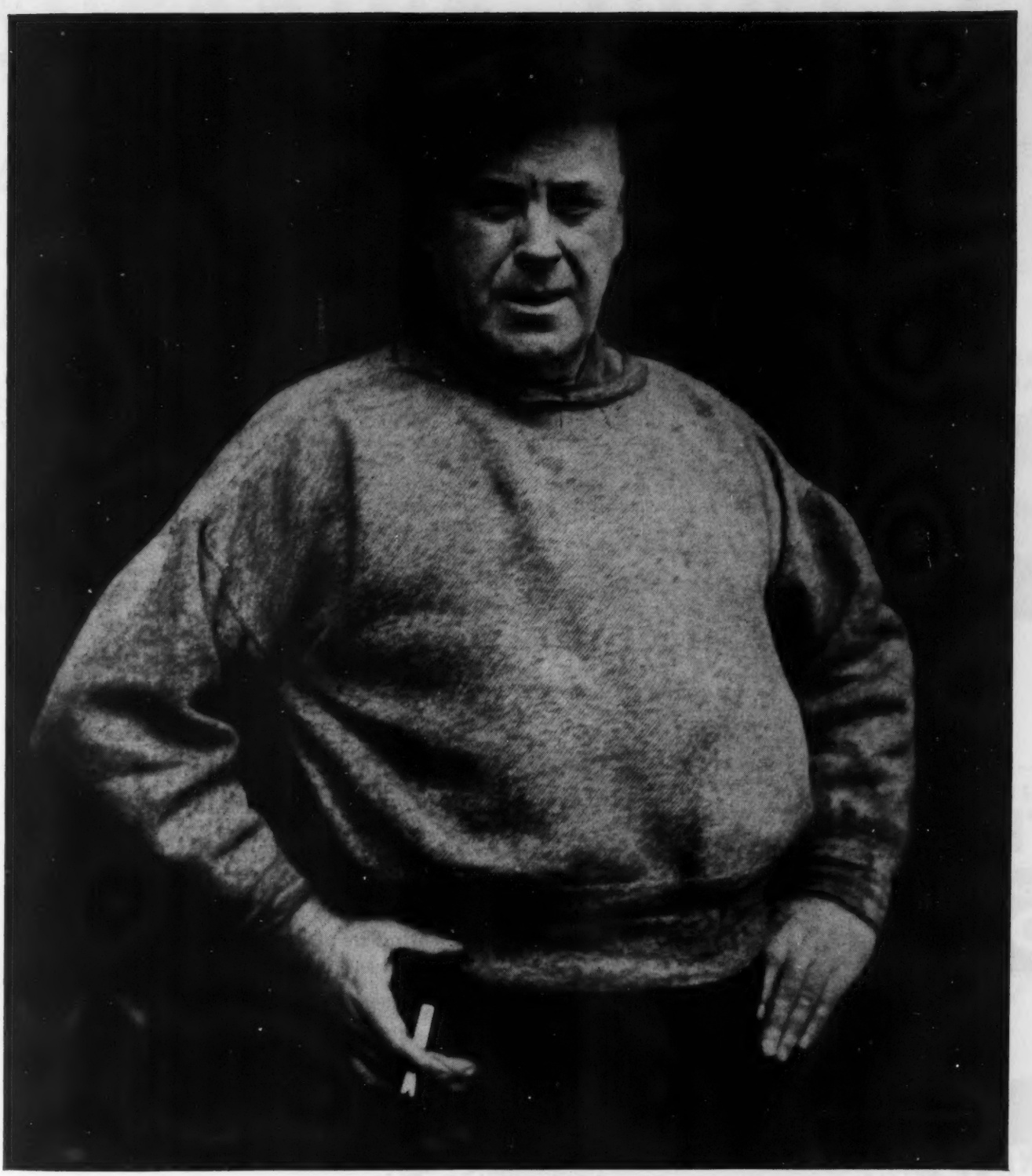
Should the supply of crude rubber be shut off, the synthetic industry would face an entirely different situation. Instead of being a specialty product, as at present, synthetic rubber would then have to replace or supplement our natural rubber supply. In answer to the question: why don't we grow our own rubber trees, the answer is that all such attempts have met with failure in North America. And in South America, where the climate is suitable, it would take at least seven years for the Hevea to reach its bearing period even under the most favorable circumstances.

To replace all our present import volume of natural rubber with synthetic would be no overnight job. If our rubber supply were cut off tomorrow there is little doubt but that our present consumption of natural rubber would have to be strongly curtailed in order to extend into the total synthetic rubber phase. This could be done in several ways: objects such as toys, household utensils and the like, which are now made from rubber only because it is a cheap plastic, could be made from something else; some of the cargoes traveling in trucks, into the tires of which goes a great deal of rubber, could be transferred to freight cars; increasing amounts of reclaimed rubber could be used in tires, etc., etc. Even more important, decrease in automobile use for pleasure might save as much as 20 percent of our total rubber consumption, or prohibition of speed to below 40 miles per hour would very greatly increase tire mileage. In any event, it is believed that between judicious planning and synthetic rubber production any emergency that is presently foreseen can be met.

It is, of course, true that the various synthetic rubber processes would require a correspondingly adequate supply of raw materials or chemical intermediates. This situation, however, can be fully met by expansion of known processes. It so happens that all of the basic materials involved—even in those cases where they are not being presently derived from this source —are potential petroleum derivatives. For this reason, it is of interest to note that, on a weight basis, our annual import of crude rubber is only about one-third of one percent of the crude oil produced. Clearly then, there need be no concern over the question of raw material for supplying any reasonable demand for rubber via the synthetic route.

Swelling of Perbunan in Comparison with Rubber

Liquid in Which Sample is Immersed	Percent Weight Increase After 24-day Immersion	
	Rubber	Perbunan
n-Heptane	105	No effect
Varsol	160	20
SAE 30 motor oil	35	No effect
White mineral oil (Nujol)	90	No effect
Benzene	225	214
Oleic acid	115	No effect
Amyl acetate	210	53
Cottonseed oil	41	No effect
Carbon tetrachloride	600	160
Diethyl ether	115	23
Acetone	No effect	97
Turpentine	330	25



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Stronger Oil Markets Reflect Improved Situation

By L. J. LOGAN

FAVORABLE circumstances continue to surround the petroleum industry, and increasingly desirable operating results appear to be in store for the oil companies.

Prices of virtually all petroleum products have improved materially within the past month and still are gaining ground, and the advances have fairly well compensated refiners for the higher costs of crude, following the increase of crude postings around April 1.

Producers, in turn, through the revision of postings, have been compensated for their increasing costs of operation.

Gasoline has participated prominently in the broad advance of the markets, the average tank-car price of regular grade being now a little over ½ cent a gallon better than in the early part of this year, when gradual recovery commenced. The wholesale price now is within about ¼ cent of the average that prevailed at this time last year, and whereas the markets a year ago were weakening, they now are growing stronger.

Gasoline prices have shown noteworthy improvement not only at the refineries and in the jobber market, but also at the service stations, the betterment having been more pronounced, in fact, at the retail outlets than in the wholesale markets. The average dealer-tank-wagon price of regular grade currently is approximately ¾ cent a gallon better than in the early part of the year.

Lubricants have improved significantly. Since the beginning of the year, bright stocks have advanced at Western Pennsylvania refineries 4 cents a gallon, and neutrals have increased 3 cents. The lubricants suffered considerably when exports to Europe were greatly reduced by the war, inventories having accumulated and prices having declined. And it was not until after the commencement of this year that expansion of domestic consumption began to fairly well compensate for the loss of foreign business.

Other products also have improved in price, along with gasoline and lubricants. Kerosene is now quoted ⅛ to ⅜ cent a gallon higher than in January at Mid-Continent refineries.

Light fuel oils are holding up well in price, despite the advanced stage of the season for heating, quotations being generally the same as in January or ⅛ cent a gallon lower.

Markets for heavy fuel oils continue firm, and prices are generally about the same as at the beginning of this year.

Natural gasoline, like refined gasoline, is ½ cent a gallon higher now than in January.

Crude Gains Firm

These gains that have been made in the markets for refined products, plus the prospect of additional improvement, assure firm markets for crude oil at the present higher prices, unless the situation is impaired by unwarranted expansion of crude production and refinery runs.

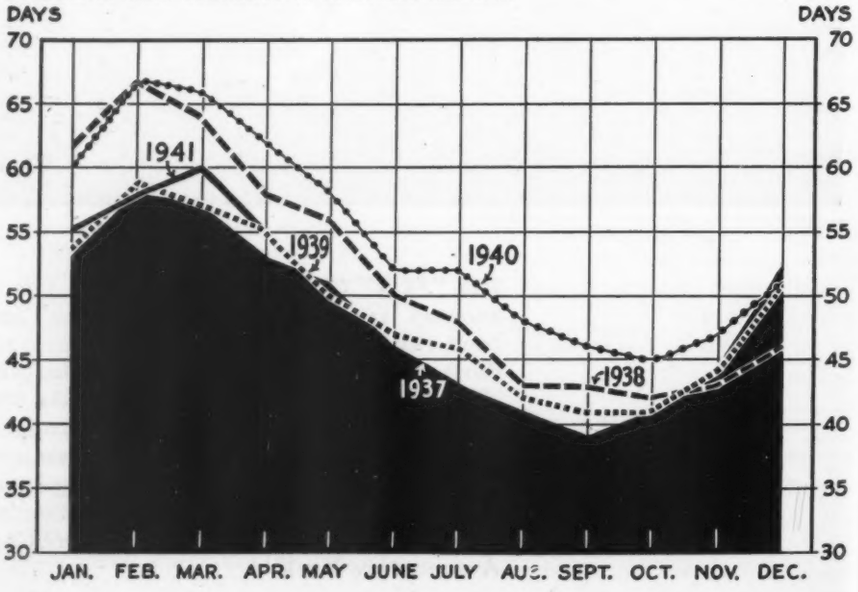
The revisions of crude postings around April 1 averaged 6 to 7 cents a barrel and affected the whole Mid-Continent and Middle-Western producing regions. And it is indicated that the increases will be not only maintained but also possibly augmented within a few weeks by further upward revisions, particularly if the gasoline market continues to improve.

Constituting the foundation for the present strong markets for refined oils and crude oil is the remarkably large demand for petroleum products. Domestic consumption has been breaking all previous records, and despite the continued relatively small volumes of export business, total demand has been greater than ever before.

Evidence of continued large demand was reflected in the latest monthly forecast of the Bureau of Mines. The bureau estimated that the domestic demand for motor

Days' Supply of Gasoline in Storage at Beginning of Month

In terms of days' supply at prevailing rates of consumption, gasoline stocks are quite moderate, having been so far this year only a little higher than in 1937, when inventories were conducive to favorable markets.



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5 **PERFECT GASKET JOINTS WITH MINIMUM BOLT TENSION** because misalignment of parts is impossible, which also eliminates frequent cause of glass breakage.

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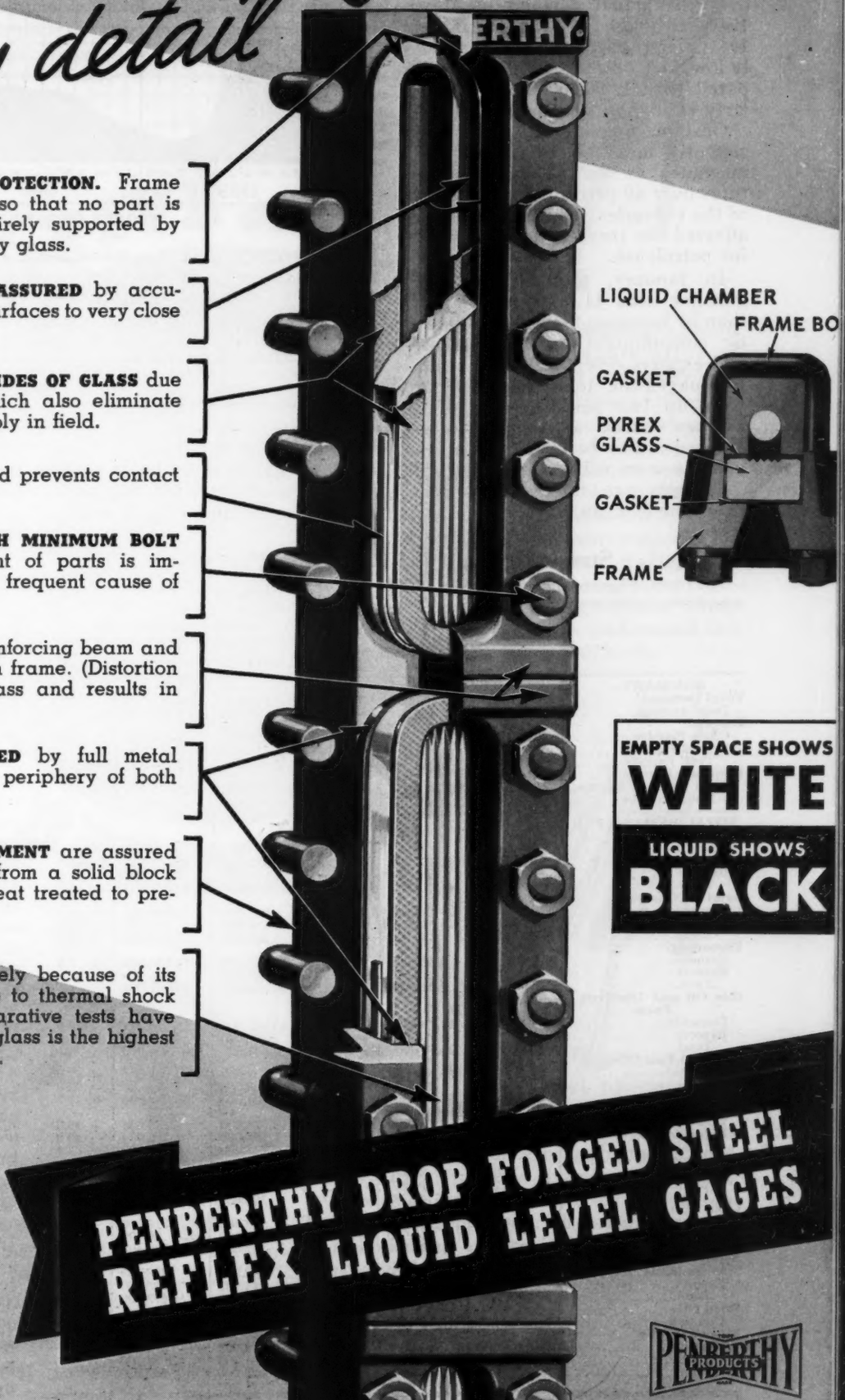

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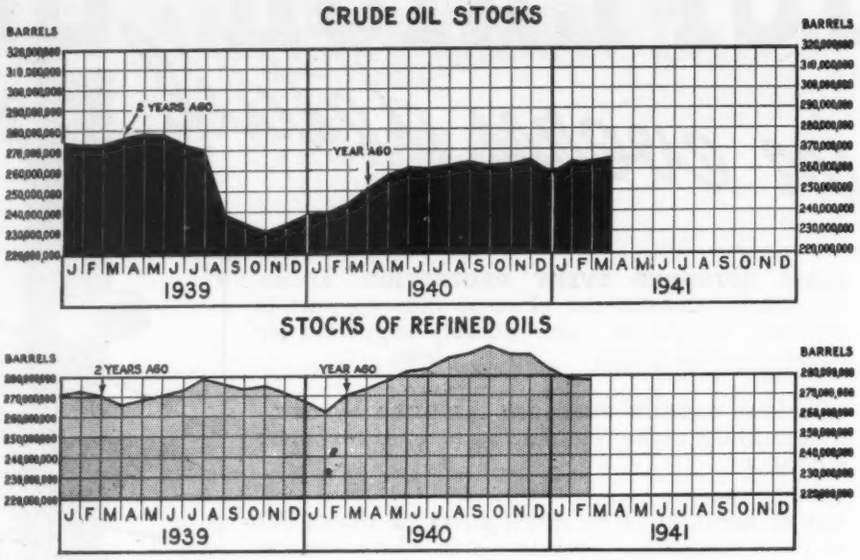
fuel in May would be 58,500,000 barrels, an increase of 10.5 percent over the actual demand in May, 1940, although exports for May, 1941, were expected to be relatively low, at 1,700,000 barrels, as compared with 1,900,000 barrels similarly estimated for April.

Gasoline demand has been consistently large all this year, and inasmuch as that product constitutes over 40 percent of the output of the refineries, it has importantly affected the trend of total demand for petroleum.

In January, total demand for gasoline was 11.1 percent larger than in January, 1940, with domestic consumption up 12.3 percent and exports down 10.1 percent. In February, the total requirements were up 14.2 percent, on a daily average basis, as domestic use showed a 16.5 percent gain, while exports were off 26.8 percent.

Figures are not yet available from the Bureau of Mines on demand in March and April. But statistics on gasoline stocks and production have indicated continuation of demand along the favorable trend of the first two months of the year. Actually, demand probably has somewhat exceeded the relatively optimistic forecasts of the Bureau of Mines.


CRUDE OIL STOCKS
BARRELS
2 YEARS AGO
YEAR AGO
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1939
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STOCKS OF REFINED OILS
BARRELS
2 YEARS AGO
YEAR AGO
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1939
1940
1941

Strong Demand for Petroleum Prevails

Figures indicate barrels, and are from Bureau of Mines

	FEBRUARY			FIRST TWO MONTHS		
	1940	1941	Percent Change	1940	1941	Percent Change
SUMMARY—						
Total Demand	107,105,000	112,760,000	+ 5.3	233,824,000	239,512,000	+ 2.4
Daily Average	3,693,000	4,027,000	+ 9.0	3,897,000	4,060,000	+ 4.2
Exports:						
Crude Petroleum	3,327,000	1,342,000	— 60.0	7,529,000	3,029,000	— 60.0
Refined Products	5,765,000	4,190,000	— 27.3	12,491,000	9,721,000	— 22.2
Total Exports	9,092,000	5,532,000	— 39.2	20,020,000	12,750,000	— 36.3
Domestic Demand:						
Total Domestic Demand	98,013,000	107,228,000	+ 9.4	213,804,000	226,762,000	+ 6.1
Daily Average	3,380,000	3,830,000	+ 13.3	3,563,000	3,843,000	+ 7.9
TOTAL DEMAND FOR PRODUCTS—						
Motor Fuel:						
Domestic	37,557,000	42,253,000	+ 12.5	77,927,000	87,597,000	+ 12.4
Exports	1,903,000	1,365,000*	— 28.3	4,177,000	3,410,000	— 18.4
Total	39,460,000	43,618,000	+ 10.5	82,104,000	91,007,000	+ 10.8
Aviation Gasoline:						
Domestic	397,000	483,000	+ 21.7	901,000	1,046,000	+ 16.1
Exports	279,000	355,000†	+ 27.2	457,000	795,000	+ 74.0
Total	671,000	838,000	+ 24.9	1,358,000	1,841,000	+ 35.6
Kerosene:						
Domestic	6,263,000	6,484,000	+ 3.5	13,905,000	14,253,000	+ 2.5
Exports	298,000	82,000	— 72.6	689,000	174,000	— 74.7
Total	6,561,000	6,566,000	+ 0.1	14,594,000	14,427,000	— 1.1
Gas Oil and Distillate Fuels						
Domestic‡	17,623,000	17,720,000	+ 0.6	40,085,000	38,718,000	— 3.4
Exports	1,234,000	791,000	— 37.0	2,783,000	2,386,000	— 14.3
Total	18,857,000	18,511,000	— 1.8	42,868,000	41,104,000	— 4.1
Residual Fuel Oils:						
Domestic	27,123,000	30,917,000	+ 14.0	59,596,000	64,255,000	+ 7.8
Exports	769,000	975,000	+ 26.8	1,908,000	1,977,000	+ 3.6
Total	27,892,000	31,892,000	+ 14.3	61,504,000	66,232,000	+ 7.7
Lubricants:						
Domestic	1,522,000	1,798,000§	+ 18.1	3,576,000	4,165,000	+ 16.5
Exports	1,089,000	744,000	— 31.7	2,157,000	1,278,000	— 40.8
Total	2,611,000	2,542,000	— 2.6	5,733,000	5,443,000	— 5.1
Wax (thousands of pounds)						
Domestic	17,028	30,837	+ 81.1	52,215	68,561	+ 31.3
Exports	28,267	10,950	— 61.3	49,409	24,179	— 51.1
Total	45,295	41,787	— 7.7	101,624	92,740	— 8.7
Coke (short tons):						
Domestic	125,700	118,600	— 5.7	263,500	314,100	+ 19.2
Exports	5,500	15,000	+172.7	22,100	26,300	+ 19.0
Total	131,200	133,600	+ 1.8	285,600	340,400	+ 19.2
Asphalt (short tons):						
Domestic	143,300	231,800	+ 61.8	292,800	438,300	+ 49.7
Exports	24,100	13,400	— 44.4	43,400	35,300	— 18.7
Total	167,400	245,200	+ 46.5	336,200	473,600	+ 40.9
Road Oil:						
Domestic	68,000	64,000	— 5.9	200,000	189,000	— 5.5
Miscellaneous:						
Domestic	35,000	232,000	+562.9	275,000	474,000	+ 72.4
Exports	211,000	45,000	— 78.7	251,000	84,000	— 66.5
Total	246,000	277,000	+ 12.6	526,000	558,000	+ 6.1

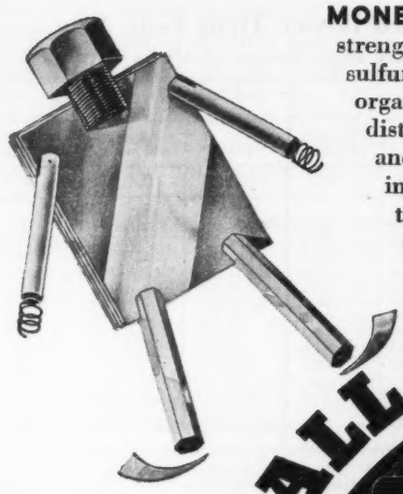
* Includes benzol—23,000 barrels. † Includes 63,000 barrels anti-knock compounds. ‡ Foreign bunker oil, 1941—Jan. 672,000 barrels Diesel; 1,315,000 barrels residual; Feb. 1,016,000 barrels Diesel, 1,272,000 barrels residual. § Includes 1,000 barrels imported for domestic use.

Stock Situation Improved

By virtue of the large demand for gasoline, stocks of that product have been brought gradually into much more favorable relation to the market requirements than they were in 1940, and the better inventory situation has made possible the improvement of prices this year.

On April 1, 1941, gasoline stocks represented only about 55 days' supply at the rate of demand indicated for the month, whereas the stocks of April 1 last year represented 62 days' supply. The present inventory in terms of days' supply is about the same as that on hand at this season in 1937, which was for the oil industry an especially profitable year.

Total stocks of gasoline on April 19, 1941, amounted to 97,899,000 barrels, nearly 6,000,000 barrels, or 5.5 percent, less than the 103,622,000 barrels on hand a year previously. Furthermore, nearly 2,000,000 barrels more of aviation gasoline is included now than a year ago in the totals given. Consequently, the indicated inventory of ordinary gasoline as of April 19, 1941, was only 91,060,000 barrels, as compared with 98,588,000 barrels in storage April 19, 1940, a decrease since a year ago of 7,528,000 barrels, or 7.6 percent. In the face of this decrease, as previously mentioned, demand for gasoline is up around 10 percent, and consequently, as shown, the present inventory represents considerably



MONEL*... ⅔ Nickel and ⅓ copper, is noted for its strength, and its resistance to such refinery corrosives as sulfuric and hydrochloric acids, brines and sea water, organic solvents, phenol, furfural and sour crudes, and distillates below 500° F. Widely used for pump rods and shafts, valves, heat exchanger tubes and linings, orifice plates, filter cloth, fractionating tower vapor space linings, centrifuge bowls, condenser tubes, and many other applications.

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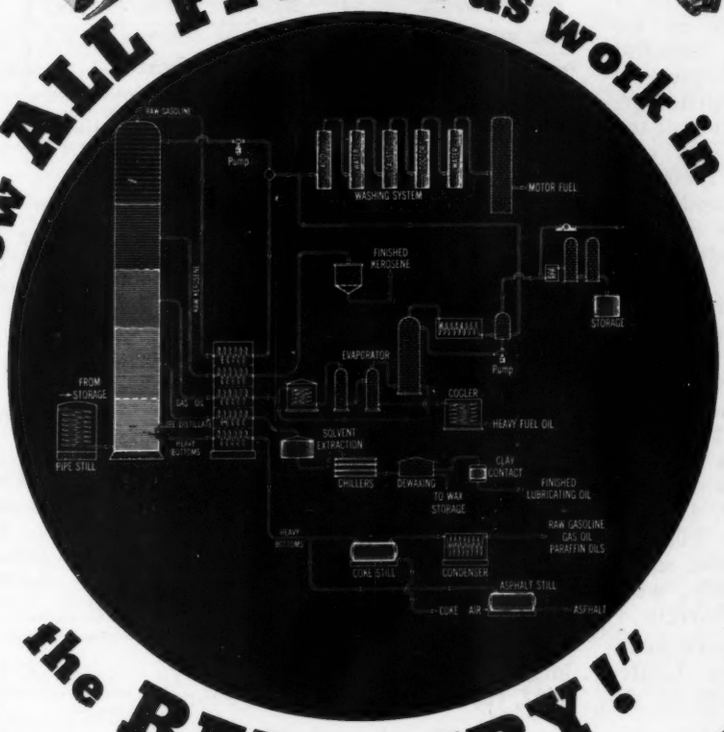

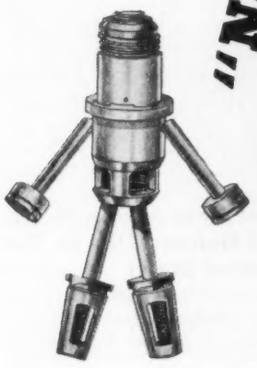

"K" MONEL*... a heat-treatable alloy of Nickel, copper and aluminum. Offers the corrosion resistance of Monel with even greater strength and hardness. An excellent material used as standard in many refineries for rods, shafts, and sleeves of pumps handling refluxes, naphthas, acid-treated and re-run stocks.

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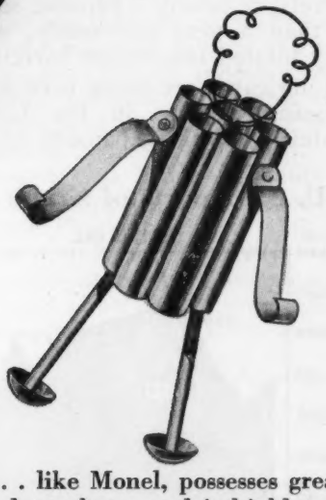

NICKEL*... like Monel, possesses great strength and toughness and is highly resistant to many refinery corrosives. It offers excellent resistance to hydrochloric acid resulting from the hydrolysis of chlorinated solvents and is used for chlorinators for various products. Also used for phenol condensing and cooling equipment, and as Nickel-clad steel for stills and other petroleum equipment.

INCONEL*... an alloy of Nickel and chromium, offers greater resistance to sulfur attack at high temperatures than do Monel or Nickel, and is available in same mill forms... plate, sheet, strip, rod and tubing. Also available as Inconel-clad Steel.

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fewer days' supply than did that on hand a year ago.

Under the dominant influence of the trend of gasoline demand, the total demand for all oils, on a daily average basis, was 9 percent larger in February, 1941, than in February, 1940, with domestic consumption up 13.3 percent, while lower exports partially offset that gain.

February results were relatively better, however, than those of January, and for the first two months of this year, total demand, on a daily average basis, was up 4.2 percent, while domestic demand showed a 7.9 percent increase.

Residual fuel oil is in particularly good demand, in reflection of the large use currently by the railroads, shipping lines, factories, mills, mines, smelters, and electric power plants, as the national defense program proceeds. Total demand for those heavy oils was 14.3 percent larger in the 28 days of February, 1941, than in the 29 days of February, 1940, with exports as well as domestic use greater. In January, domestic consumption was up about 3 percent, but exports were not as large as a year previously. Stocks of residual fuel oil on April 19, 1941, at 95,636,000 barrels, were 7,000,000 barrels, or nearly 7 percent, smaller than a year previously, when they totaled 102,603,000 barrels.

Lubricants are being used in increasing volume in the United States, and the expansion of domestic consumption has almost compensated for the loss of large export markets since the war began. In the 28 days of February, 1941, domestic demand for lubricants was 18 percent greater than in the 29 days of February, 1940. But exports were one third lower, and total demand showed a 2.6 percent decrease. These figures indicated improvement over those for January.

Because of milder weather the past winter than the one before, demand for light fuel oil has been slightly smaller this year than last year. Domestic consumption of gas oil and distillate fuel was slightly larger in the 28 days of February, 1941, than in the 29 days of February, 1940, but exports were smaller, and there was a decrease of 1.8 percent in total demand. Stocks of the light oils are about 4,000,000 barrels (17 percent) larger than a year ago, having totaled 28,410,000 barrels April 19, but that increase is justified by the prospect of increased demand.

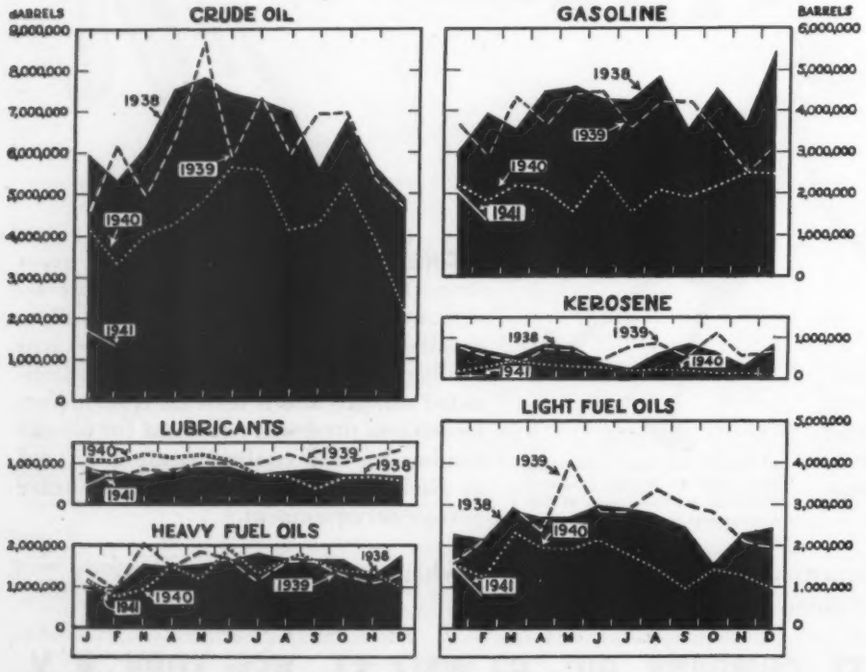
Oil Exports About One Third Lower Than Year Ago

Figures indicate barrels, and are from Bureau of Mines

ITEM	FEBRUARY 1940	FEBRUARY 1941	FEBRUARY Percent Change	FIRST 2 MONTHS 1940	FIRST 2 MONTHS 1941	FIRST 2 MONTHS Percent Change
Crude Oil	3,327,000	1,342,000	— 59.7	7,529,000	3,029,000	— 59.8
Products:						
Motor Fuel	1,903,000	1,365,000*	— 28.3	4,177,000	3,410,000	— 18.4
Aviation Gasoline	279,000	355,000†	+ 27.2	457,000	795,000	+ 74.0
Kerosene	298,000	82,000	— 72.5	689,000	174,000	— 74.7
Gas Oil and Distillate	1,234,000	791,000	— 35.9	2,783,000	2,386,000	— 14.3
Residual Fuel Oil	769,000	975,000	+ 26.8	1,908,000	1,977,000	+ 3.6
Lubricants	1,089,000	744,000	— 31.7	2,157,000	1,278,000	— 40.8
Wax (thousands of pounds)	28,267	10,950	— 61.3	49,409	24,179	— 51.1
Coke (short tons)	5,500	15,000	+ 172.7	22,100	26,300	+ 19.0
Asphalt (short tons)	24,100	13,400	— 44.4	43,400	35,300	— 18.7
Miscellaneous Oils	211,000	45,000	— 78.7	251,000	84,000	— 66.5
‡ Total Refined Products	5,765,000	4,190,000§	— 27.3	12,491,000	9,721,000	— 22.2
Total Crude and Products	9,092,000	5,532,000§	— 39.2	20,020,000	12,750,000	— 36.3

* Includes benzol—23,000 barrels. † Includes 63,000 barrels anti-knock compounds. ‡ Not the sum of the above figures, some of which do not indicate barrels. § Exclusive of 11,000 barrels exported from non-contiguous territories but inclusive of 623,000 barrels shipped from U. S. to territories and inclusive of 115,000 barrels withdrawn from bond for export.

U. S. Exports of Crude Petroleum and Refined Products



Source of Data: Bureau of Mines.

Changes From Year Ago in Stocks of Crude and Refined Oils in The United States

(Figures indicate Barrels)

LATEST WEEKLY DATA

(Sources: Crude stocks, Bureau of Mines; all other figures, American Petroleum Institute)

STOCKS OF:	April 19, 1940	April 19, 1941	Percent Change
Gasoline	103,622,000	97,899,000	— 5.5
Gas Oil & Distillate	24,290,000	28,410,000	+17.0
Residual Fuel Oil	102,603,000	95,636,000	— 6.8
Crude Oil	*252,269,000	†265,160,000	+ 5.1

LATEST MONTHLY DATA

(Source: Bureau of Mines.)

ITEM	Stocks at End of February 1940	1941	Percent Change
SUMMARY—			
Crude Petroleum:			
Refinable in U.S.	244,417,000	264,432,000	+ 8.2
Heavy in California	13,408,000	11,886,000	—11.4
Natural Gasoline	4,757,000	5,311,000	+11.6
Refined Products	270,464,000	277,894,000	+ 2.7
Total, all oils	533,046,000	559,523,000	+ 5.0
Days' supply:			
February basis	144	139	— 3.5
2 Months' Basis	137	138	+ 0.7
PRODUCTS—			
Gasoline:			
Finished	92,721,000	88,697,000	— 4.3
Unfinished	4,757,000	5,311,000	+11.6
Total	97,478,000	94,008,000	— 3.6
Aviation Gasoline	4,264,000	6,672,000	+56.5
Kerosene	4,302,000	7,634,000	+77.5
Gas Oil & Distillate Fuels	24,640,000	34,875,000	+41.5
Residual Fuel Oils	89,784,000	84,049,000	— 6.4
Lubricants	7,825,000	8,790,000	+12.3
Wax (Thousands of pounds)	82,631	119,150	+44.2
Coke (short tons)	628,000	375,000	—40.3
Asphalt (short tons)	647,000	760,000	+17.5
Road Oil	809,000	760,000	— 6.1
Miscellaneous	320,000	365,000	+14.1
Other Unfinished Oils	36,495,000	39,284,000	+ 7.6

* Stocks April 13, 1940.
† Stocks April 12, 1941.

[*Continued from page 52*]

uct. Extraction of natural gasoline from natural gas is an essential step in the functioning of natural gas pipe line systems. Without its removal, long distance transportation of natural gas would not be economically feasible.

"Authorities have estimated for approximately each 18 gallons of natural gasoline produced, a barrel of oil is saved. This means that the industry has prevented extinction of crude oil reserves by something in excess of a billion barrels.

"The great petroleum industry, of which the natural gasoline industry is part, has been alert to its opportunities and responsive to its obligations. Research has played a major part in the developing of processes for the production of new products on a large scale. It has served the American public and our nation well.

"An introspective analysis of the oil, natural gas and natural gasoline industries indicates that there are ample reserves, financial strength and technological ability to meet, not only normal requirements, but also the emergency demands of the national defense program as well. These industries are among the very few that are able and prepared to meet these extraordinary requirements instantly.

"Let me 'blitzkrieg' you with some of the facts. Proven oil reserves are estimated at about 18.5 billion barrels and natural gas at 85 trillion cubic feet. Both are being produced so that supply meets demand, and conservation to eliminate waste is the order of the day.

"In 1940 motor-fuel production reached 26 trillion gallons, natural gasoline 2.3 trillion gallons, liquefied petroleum gases exceeded 165 million gallons, and lubricants over 36 millions of barrels.

"There are 125,000 miles of oil and gasoline pipe lines, over 85,000 miles of natural-gas pipe lines ready to deliver these products to most of the strategic points of the nation. There are 148,000 tank cars to augment the delivery of petroleum and petroleum products to any point reached by rail. To supplement pipe-line and rail transportation, there are operating in the nation 75,000 tank trucks. There are 467 oil tankers (20 owned by the government) with a capacity of 2,950,000 gross tons capable of carrying 34 million barrels of petroleum and by-products. Current stocks of finished motor fuel gasoline are about 3500 million gallons, 144 million barrels of fuel oil and

The Look Box

8.75 million barrels of lubricating oils.

"The nation has a huge production of food products which can be increased by an agricultural policy of producing more rather than less. But we must wait for the season to rotate and we are greatly influenced by the elements.

"The steel industry is moving forward toward taking care of normal requirements along with defense needs, but they are far behind in deliveries. If we become short in the production of copper we can buy from the surplus of South America.

"The natural resources industries, of which we are an integral part, are already ahead of the emergency requirements of the defense program.

"Our modern scientists and research men are alert and wrapped up in the process of solving all of the technological problems touching defense requirements. Synthetic materials have been developed which can be substituted for former imports. We are ahead of the world in the field of plastics and they are playing a great part in the defense program. Before the end of this emergency period many new discoveries will be made that will not only be an aid but will be a lasting contribution to the civilization of the future.

"We can be proud of the part that our industry is taking in the preparedness program. We can furnish the fuel, the energy, many of the chemicals and the lubrication that creates speed and mobility in carrying out the defense program or of actual warfare. There is hardly anything in connection with this program that oil and gas or its by-products fail to touch.

"The natural gasoline industry is the back log in the production of high-octane gasoline that makes our air force the fastest and most efficient in the world. Our products furnish the vast industrial needs of many concerns manufacturing war products.

"The program will create many new problems that will make it necessary to devote double time and triple thought to our operations. Management will have many worries and we must be tolerant and cooperate with it. Many of our operations will not be profitable during this war-time emergency. It is certain that the natural-gasoline industry, the natural-gas industry, and the oil industry are marching forward in unison for the defense of our nation and our democratic form of government.

"However, a word of caution should be sounded. In this present emergency industry is on trial. If defense needs and requirements are not anticipated and adequately taken care of by private enterprise, government will take over. When the government steps into our industries, we approach the dictatorship form of government where free enterprise and individual initiative cease to exist. It is not difficult to find tendencies in this direction already.

"We have the men, machines and the resources to defend our democracy and the best expression I can give you of the value of defending such a democracy is in the words from an editorial of the New York Times (August 26, 1940) which states:

"'It is worth the best and utmost a man, a woman or a people have to give. It is worth more than life. Men and women have died and are now dying for it. It is a thing of glory, a banner in the wind, a trumpet blowing. If it were uni-

CONVENTIONS

MAY	
19–21	American Institute of Chemical Engineers, Chicago.
19–22	American Petroleum Institute, Mid-Year Meeting, Mayo Hotel, Tulsa.
JUNE	
1– 6	Society of Automotive Engineers, White Sulphur Springs, W. Va.
9–10	Liquefied Petroleum Gas Association, Pacific Coast Section, Fairmont Hotel, San Francisco.
19–20	Pennsylvania Grade Crude Oil Association, Bradford, Pa.
23–27	American Society for Testing Materials, Palmer House, Chicago.
SEPT.	
8–12	American Chemical Society, Chalfonte-Haddon Hall, Atlantic City.
17–19	National Petroleum Association, Hotel Traymore, Atlantic City.
29–30	National Lubricating Grease Institute, Stevens Hotel, Chicago.
OCT.	
16–18	American Institute of Mining and Metallurgical Engineers, Petroleum Division, Dallas.
31	California Natural Gasoline Association, Los Angeles.
NOV.	
2– 7	American Petroleum Institute, St. Francis and Palace Hotels, San Francisco.

versal, peace, too, would be universal. But it will not lastingly surrender to any arbitrary power, however armed, however fantastical. For because it has power to stir the hearts of men as nothing else can stir them, it will speak if it must with an unconquerable, an irresistible fury.' "

Chemical Engineers Meet November 3, 4 and 5

The thirty-fourth annual meeting of the American Institute of Chemical Engineers, will be held November 3, 4 and 5 at Virginia City, Virginia. The Cavalier Hotel will be headquarters.

Fuel and Corrosion On API Program

Symposiums on fuel economy and corrosion of refinery equipment will be considered at two sessions of the Division of Refining at the mid-year meeting of the American Petroleum Institute, Tulsa, May 19 to 22. A third session will consist largely of progress reports by committees.

The general subject of fuel economy in refining will comprise the morning session May 21 with the following program:

"The Economies of Flue Gas Recirculation and Economizers in Fired Tubular Heaters for Oil Refineries," C. C. Nelson, Standard Oil Development Company, Elizabeth, New Jersey.

"Air Preheaters for Petroleum Heaters," L. A. Mekler and H. A. Becker, Universal Oil Products Company, Chicago.

"Generation of Steam as a Factor in Modern Refinery Heat Economy," W. W. Kraft, V. Mekler and R. H. Reimenschneider, The Lummus Company, New York.

"Fuel Economy in Refineries," D. C. Lawrence, The Texas Company, New York.

"Regenerative Type Air Heaters for Refinery Use," O. F. Campbell and T. B. Kimball, Sinclair Refining Company, East Chicago.

The consideration of corrosion of refinery equipment will be heard that afternoon as follows:

"Water-Side Corrosion of Condensing Equipment," B. B. Morton, development and research division, The International Nickel Company, New York.

"Corrosion of Copper-Alloy Condenser Tubes by Water," James T. Kemp, the American Brass Company, Waterbury, Connecticut.

"Water Treatment to Prevent Corrosion," W. J. O'Connell, Wallace & Tiernan Products, Inc., Newark, New Jersey.

"Cathodic Protection of Open-Tank Condensers," N. A. Miller, Universal Oil Products Company, Chicago.

"Corrosion Prevention on the Water Side of Refinery Equipment" will be dealt with in the three following papers:

"Chemical Treatment of Water," W. H. Atwell, The Texas Company, Port Arthur.

"Use of Deaerator," W. H. Atwell, The Texas Company, Port Arthur.

"Cathodic Protection," V. L. Neely, The Texas Company, Houston.

"Chlorination of Condenser Waters," D. R. Johnson, Continental Oil Company, Ponca City.

"Deacidizing and Desalting Crude Oils," W. G. B. Hanson, Petroleum Rectifying Company, Houston.

For its program of May 22 the division of refining will hear the following reports of committees:

"Evalution of Diesel Fuels in Full Scale Engines—Report of the CFR Committee," presented by Walter Ainsley, Sinclair Refining Company, East Chicago.

"1940 Road Detonation Tests—Compiled from Report of CFR Committee," presented by W. M. Holaday, Socony-Vacuum Oil Company, New York.

"API Motor Fuel Research," presented by D. P. Barnard, IV, Standard Oil Company of Indiana, Chicago.

For the general session luncheon May 21 Governors Leon C. Phillips of Oklahoma and Payne Ratner of Kansas will be speakers. This will be the only general session. A complimentary dinner will be given the evening of May 21 at the coliseum. Oil companies and supply companies of Tulsa will be hosts.

Committee meetings will start May 17 and continue through the morning of May 22.

Superintendent of Pennzoil Plants Dies

Luther D. Fulton, superintendent of refineries of the Pennzoil Company died at his home in Titusville April 2. He joined the concern in 1901. In his work in refining he had developed several devices on which he held patents. Fulton served four years as mayor of Titusville, where he was born.

It Pays to Fight Coke and Carbon with MODERN ROTO Guns

Modern equipment is as vital in your plant as at the front. Rising operating costs and taxes must be countered with modern time and labor saving equipment. The powerful new Roto will produce substantial savings in time, labor and materials consumed in cleaning tubes in your stills, cracking coils, boilers and heat exchangers. It works like a machine gun. The rapid-action "trigger" air valve on the motor enables one man to clean tubes by himself faster than a man and helper using old type guns.

New, more durable materials, sharp, rugged, self-feeding cutter heads and long-lasting hose assure you of greatly increased tube cleaning effectiveness and lower cost of upkeep.

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2. **Would atmospheric coolers in the base of the cooling tower, or shell or tube units some distance from the tower, be the better selection?**
3. **Can cold water be advantageously circulated in series; for instance, first, through overhead condensers, and then through heavy side stream coolers?**
4. **Is the cost of water treatment, to allow trouble-free operation at very high water outlet temperatures from coolers, justified by operating and possibly first cost savings?**
5. **Is a natural draft, forced draft, or induced draft tower the best selection?**
6. **In order to cool products to a specified temperature, what is the economic relation between water temperature approach to wet bulb temperature in the cooling tower, and product temperature approach to water temperature in the condenser or cooler?**

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Natural Gasoline in The National Economy

The role of natural gasoline in the national economy, especially its part in national defense, dominated the twentieth anual meeting of the Natural Gasoline Association of America, Dallas, April 23, 24 and 25. Even the technical papers were in part a revelation in what chemicals and other ingredients for war purposes may be taken from hydrocarbons.

The meeting drew 450 registrations, a figure that was not anticipated due to the fact that the association was holding its first meeting outside of Tulsa.

The Hanlon Award went to Alois Kremser, assistant director of research, Standard Oil Company of California. He was the fifth man to be honored. Other names on the plaque are R. C. Alden, Phillips Petroleum Company; J. W. Cowles, Shell Oil Company; G. G. Oberfell, Phillips Petroleum Company, and Dr. G. G. Brown, University of Michigan.

Officials for the coming year are: Ray E. Miller, Hanlon-Buchanan, Inc., Tulsa, president; J. R. Jarvis, Lone Star Gasoline Company, Dallas; H. H. Beeson, Sabine Valley Gasoline Company, Shreveport; H. A. Ells, Cities Service Oil Company, Bartlesville and J. W. Vaiden, Skelly Oil Company, Tulsa, vice presidents.

Directors elected for two years are: R. E. Cornwell, Carbide and Carbon Chemicals Corporation, New York; R. A. Carter, Continental Oil Company, Ponca City; H. A. Ells, Cities Service Oil Company, Bartlesville; J. R. Jaevis, Lone Star Gasoline Company, Dallas; L. B. Jackson, Oklahoma Gasoline Plants, Inc., Sapulpa; Fred F. Ketchum, Owens-Libby-Owens gas department, Charleston; John B. Atkins, Parade Gasoline Company, Shreveport; T. R. Goebel, Shell Oil Company, Houston; R. D. Gibbs, Union Oil Company, Los Angeles, and R. N. Parks, Virginian Gasoline & Oil Company, Charleston.

These together with 14 members who were elected for two years at the 1940 meeting will fix policies of the association during the year.

Growing importance of recycling and liquefied petroleum gases was evident from both technical papers. George P. Bunn, retiring president, said that output of recycling plants might reach several hundred thousand barrels daily within a few years. D. A. Sillers, Lone Star Gas Company, Dallas, devoted a paper to "Making Gas Measurement Balance in a Cycling Plant." "Safety Standards in the Liquefied Petroleum Gas Industry," was presented by B. L. Brennan, Philgas Division, Phillips Petroleum Company, Bartlesville.

Three subjects were covered in reports of the Technical Committee. H. G. Beeson, vice chairman of the committee, confined its report to "Conversion Tables for Liquefied Petroleum Gases." Other reports were on the Reid Vapor Pressure Section and the Fractional Distillation Section.

In reporting for the Gas Testing Committee, G. L. Oder, chairman, said:

"The revision of the charcoal absorption test code, which was in a somewhat embryonic state when the committee report was made last year, has with the exception of the activation test, been completed and adopted by the committee and submitted to the board of directors for consideration."

The annual kinks contest ran through most of April 25, the closing day. The five prize winners were:

Grand Prize—Clarence Lesher, plant superintendent, Skelly Oil Company, Fairfax, Oklahoma, boiler feed-water treating pump.

Class A—James W. May, pump repairman, Phillips Petroleum Company, Oklahoma City, spring packing saver.

Class B—Al Tromley, meterman, Warren Petroleum Corporation, Galva, Kansas, plug gauge for orifice-meter plates.

Class C—D. W. Hunsaker, chief operator, Phillips Petroleum Company, Crane, Texas, absorber level-control system.

Class D—Louis F. Karlin, machinist, Skelly Oil Company, Skellytown, Texas, combination micrometer.

Entertainment for the convention was provided by the Natural Gasoline Supply Men's Association.

A resolution was passed in honor of the late Frank L. Chase, vice president of Lone Star Gas Company as well as a vice president of the association over a long period.

Progress within the industry and indicated trends were outlined by George P. Bunn, who retired after two terms as president, as follows:

"It seems to me most fitting that the twentieth annual meeting of the Natural Gasoline Association of America should be convening here in Texas, the state which alone now produces more than one third of the natural gasoline output of the nation, a state in which so many of our associates reside. It is appropriate, also, that we should meet here in the friendly city of Dallas, the convenient, almost equidistant point from extreme locations in all parts of the Mid-Continent area. We are grateful to our Texas hosts who have seen to all the necessary arrangements for making this a profitable convention. I hope this choice of meeting place, decided about a year ago by the directors of our association, will fulfill the mission intended—that of permitting many new folks to hear the reports of the experts whom our program has assembled, to participate in the many discussions and to be stimulated and impelled by the new ideas, the new solutions to old problems which may be presented.

"What matters should your president discuss in reporting on the state of the industry? Can his address, always given a place of prominence on the opening day of the convention, be more than perfunctory—merely a filler of space? I think certainly it should be more than this and I have approached the assignment seriously, hoping that you will regard my observations carefully; that you might even re-read them later, and though you may not in each case agree, your thinking and acting may be chal-

Officials of the Natural Gasoline Association of America, seated, left to right: Ray E. Miller, Hanlon-Buchanan, Inc., Tulsa, president; J. R. Jarvis, Lone Star Gasoline Company, Dallas, vice president.

Standing left to right are the other three vice presidents: H. H. Beeson, Sabine Valley Gasoline Company, Inc., Shreveport; H. A. Ells, Cities Service Oil Company, Bartlesville; and J. W. Vaiden, Skelly Oil Company, Tulsa.

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When you give factory and warehouse floors the rugged protection of "A. W." Rolled Steel Floor Plate, you make a long-term investment in good plant management. Steady traffic, heavy loads, toughest wear will not damage or impair it. There are no worn and slippery surfaces to endanger men on foot. No cracks or ridges to upset floor trucks. Oil-proof, heat-proof, fire-proof, crack-proof. Easy to clean, quick to drain. Made in five patterns. The Super-Diamond Pattern is shown here. Write for folder.
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lenged to progress. Note well these observations:

"The natural gasoline production of Texas, now more than 30 percent of the nation's total, may slump to less than one tenth of this amount by July 1, 1941, because of misguided taxation of natural resources! The return of the industries and homes of the country to the more or less exclusive use of coal and coal products and the restriction of production and use of natural gas, butane and other gas products, as urged by mining labor, coal producers and distributors and proposed by federal agencies to be effected through federal control, will stifle free competition and restore inconvenience and expense to millions of consumers! National liquefied petroleum gas consumption, increasing over 800 percent in the last seven years is testimony to ready consumer reception, to its advancing economic possibilities and is a tribute to remarkable engineering and sales effort! Distillate, natural gasoline and other gas product recovery from high pressure gas recycling operation adds millions of gallons to motor fuel supplies and conserves the residue gas for future consumption! Methods have been discovered by means of which the nation's normal annual requirements for motor fuel could be supplied without the use of a single barrel of crude petroleum! To these rather dramatically stated issues, and perhaps a few others, I wish to direct your further attention for a little while.

"Let us note, first, something concerning the production of natural gas and products therefrom in Texas according to information derived chiefly from the records of state agencies.

Tax Burden

"From the tax returns of producers and purchasers to the state comptroller for January, 1941, it is determined that casinghead and other gas sold to natural gasoline producers averaged about 0.86c per MCF in value at the well. It is also learned that the plants handling this gas utilized 75 percent of the taxable gas produced in the state, affording an outlet for low value natural gas and for casing-head gas and effecting the production of liquid products therefrom which otherwise would be largely wasted. Each of over 50 percent of the 150 natural gasoline plants operating in the state last year produced an average of less than 238 barrels, or 10,000 gallons, of product daily, and we all know that most of the plants could barely, if at all, continue to operate on the income derived. Introduced in the Texas legislature since January were bills which would tax the manufacture of natural gasoline, butane, propane and other products 1 cent per gallon; would tax the production of the gas as high as ½ cent per 1000 cubic feet and would levy an additional tax against manufacturers of as much as ½ cent per 1000 cubic feet for gathering gas. Even the mildest of the bills would increase the tax on some of the gas as much as 1000 percent or more! Now it is inconceivable that any legislator would seriously intend to raise taxes in any such degree or would intend a manufacturer's tax of 1 cent per gallon on 26-70 natural gasoline which averaged but 1.65c per gallon all of last year which would mean more than 1 cent per 1000 cubic feet, and would then add another ½ cent tax for gathering the gas, for the records show all gas processed yielded an average of but 0.881 gallons per 100 cubic feet. Producers of gas and manufacturers of natural gasoline must see that their legislators know the true economic facts concerning their businesses else such tax bills as cited, all bearing emergency clauses which would make them effective immediately after passage will, perhaps even by July 1, 1941, undoubtedly stop manufacture of all natural gasoline except that necessarily recovered on high-pressure-gas-distributing systems.

"We find that many Texans, even those engaged in handling gas and making gas products, do not have a comprehensive knowledge of the scope of these endeavors. Recent contacts with those interested in legislation for additionally taxing natural resources in this state have revealed a very great lack of knowledge of true facts among those who should be informed and who are responsible for and desire to establish equity in such taxation. We are led to believe that you who are engaged in these businesses have not always properly posted yourselves and in turn educated your local state representatives and senators to truly understand and care for your best interests in accordance with the aims of our democratic form of government. It was recently forcibly impressed upon us that great damage to an industry from taxation and other types of legislation can occur when such education is lacking. The duty of each of you to culti-

7 REASONS FOR USING REFRACTORY CONCRETE made with LUMNITE

REFRACTORY CONCRETE is a special-type concrete combining high cold strength with strength after exposure to high temperatures. It is made by mixing LUMNITE—a heat-resistant binder—with aggregates of refractory or insulating characteristics. Listed below are 7 important reasons why *you* should use Refractory Concrete. It offers you:

1. *A cast-in-place refractory material, formed to fit the job no matter how intricate the shape, or how hard to get at the location.*
2. *A cold-setting, moldable refractory, gaining high strength within 24 hours of placing, without firing.*
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6. *A low-cost insulating refractory. When made with high-temperature insulating aggregate, the conductivity is one-third that of ordinary refractory materials.*
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WHEREVER you want to save time and money on refractories, it will pay you to investigate Refractory Concrete. Get full information *now* by writing for your copy of the booklet, "Refractory Concrete." Address Atlas Lumnite Cement Co. (United States Steel Corp. Subsidiary), Dept. R-10, Chrysler Bldg., New York City.

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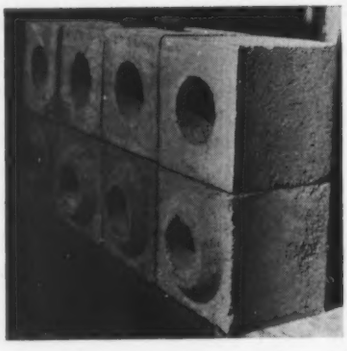
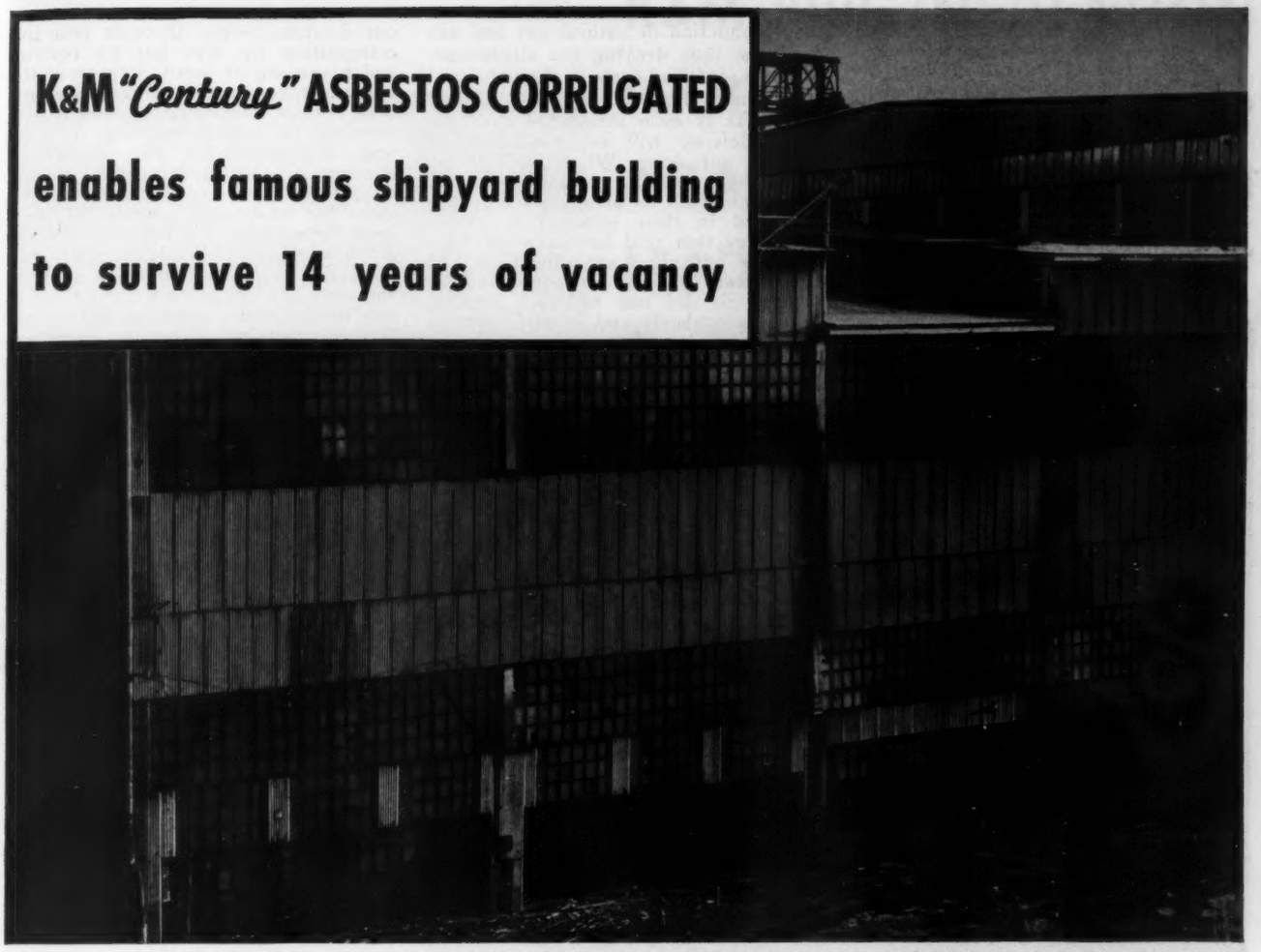


▶ Factory-prepared mixtures of LUMNITE and selected aggregates offer you a means of making Refractory Concrete simply with the addition of water. LUMNITE castables are obtainable from refractory manufacturers and their distributors. These castables have the characteristic advantages of Refractory Concrete: quick-hardening, high cold strength, sustained strength in service.

Specify Castables "Made With LUMNITE"

LUMNITE FOR REFRACTORY CONCRETE

K&M "Century" ASBESTOS CORRUGATED enables famous shipyard building to survive 14 years of vacancy



Loft building of the famous Cramp Shipbuilding Company of Philadelphia, showing the sidewalls of K&M "Century" Asbestos Corrugated after 25 years of service, during 14 of which the building was standing vacant!

The Keasbey & Mattison "Century" Asbestos Corrugated on the sidewalls of the loft building at Cramp's Shipyard is actually 25 years old, and is still in good condition. But even better evidence of its durability is the fact that this material effectively protected a vacant building for a period of 14 years! Nothing receives more punishment than an idle building.

Back in 1916, "Century" Corrugated was applied to the sidewalls of Cramp's loft building. With the decline of shipbuilding after the World War, this century-old yard closed down. Not for 25 years was even a thought given to the "Century" Corrugated sidewalls. But vessels for America's defense will soon be sliding down Cramp's shipways once again.

After 14 years of idleness, the loft building has been restored, and already it is humming with activity. Except for minor, localized damage, the "Century" Corrugated was found to be in virtually as good condition as the day it was applied!

"Century" Corrugated is fire-resisting, weather-resisting, rot-proof and rust-proof. Quickly applied. Lastingly maintenance-free. Time only toughens it. Isn't this the kind of durable, economical material needed for the sidewalls and roofing of your plant? Write Dept. 05 for new 36-page catalogue giving all the facts on "Century" Corrugated.

KEASBEY & MATTISON
COMPANY, AMBLER, PENNSYLVANIA

vate your legislators should be fulfilled and constantly attended. No effort can be so effective as your own local attention to these matters. Natural gasoline is extracted from gas produced in at least 93 counties in Texas and with the legislators from all these areas well posted as to the facts of the industry, its interests would, without doubt, always be dealt with fairly.

Attitude of Coal Interests

"Would you care to give up your cleanly, convenient gas furnace or stove and again, if you have ever done so, cut wood morning and evening or carry and stoke coal? There is a pronounced effort indicated in federal circles and petitioned quite publicly and generally by many coal interests to restrict further production of natural gas and gas products, thus denying the advantages of these preferred fuels to the industrial and domestic users of these United States. It is even insinuated that national defense will be jeopardized if this be not done. Where would our automobile and our aviation be had such deterrents to progress have been advanced in their infancy? It seems quite true that coal has been set back with the advent of gas pipe lines and butane and propane for home and industry. So did our railroads decline, relying mistakenly and smugly on their former indispensability, with the rapid rise of motor transportation. Yet new blood is being infused into railroading and so, also, must our coal industry look alert and find its proper place in our economics—not through retarding competition by law, but by reviving and advancing on merit. I speak of this not alone because of a threat to our own industry but because of sensing a growing inclination to stifle free and open competition in this country—a curbing of the fundamental principle of freedom of progression and improvement for all people, already so strikingly demonstrated in the United States as nowhere else. While one advancement dislocates an outmoded industry, the very fact encourages another. With our former waste products butane and lighter materials rising to some importance amid the vicissitudes of a declining natural gasoline economy, now finding enlarging uses making for better living and better manufacturing, we ourselves, are reaffirming this rule. We must resist this effort of our competing coal interests and we must urge our statesmen to disillusion them speedily.

"One of the striking advances among new industries, meeting the competition of coal, gas and oil, is that of distributing the liquefied petroleum gases, butane and propane. Thirty-nine million gallons in 1933; more than 300,000,000 gallons in 1940! We who make these materials have little conception of the tribulations and the problems met with in designing equipment for the distribution and use of these fuels, the overcoming of prejudices, the creation of protective and the discouragement of ruinous legislation. Here was a whole budding industry tacking up its shingle, as it were, like an energetic young lawyer facing his first setbacks, but with courage enough to continue. This effort, after several false starts but now with an aggregate attained dollar value sufficient to merit designation as a distinct industry, although already firmly established, yet has far to go. We should lend our cooperative attention to its further development as only one of the phases of the new era for natural gas products, an era in which we may find the use of natural gasoline in motor fuel blends only one of a number of important outlets.

Recycling

"The discovery of an increasing number of Gulf Coastal high-pressure-gas deposits, chiefly in Texas, some of which have low oil reserves per acre in place, others of which yield only valuable condensates upon reduction of pressure, has given impetus to a new type of original production practice—recycling. The gas produced from such formations, with as little drop in rock pressure as feasible, is usually first separated from indigenous oils or retrograde condensates and then subjected to processing for natural gasoline extraction. With no substantial market outlets for the residue from the only slightly reduced original gas, such residue is then compressed sufficiently for reintroduction into the formation from which it came. By proper selection of output and input wells and rates of flow the stripped gas can displace remaining virgin gas and oil, moving it always toward output points with minimum diffusion. Greatest ultimate production of liquid or liquefiable hydrocarbons may be thus attained, with the reservoir eventually left full of natural gas at a pressure not considerably less than the original formation pressure. The very close economies requisite for

Alkali Desalting Gives You These Advantages:

1. Reduces Hydrochloric Acid *CORROSION*

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K&M PIPE INSULATION PROTECTS FINE WOOLENS AGAINST SPOILAGE IN LEADING TEXTILE PLANT

Washing department in large Eastern textile plant, showing the cold water lines running above the washers. These lines are insulated against corrosion and condensation alike with Keasbey & Mattison materials. Material was applied by Mundet Cork Corp., approved K&M Distributor in Brooklyn, N.Y.

In addition to its normal duty of saving heat and fuel, K&M insulation often performs unusual money-saving functions. An important instance of this sort occurred in a large Eastern textile plant where fine woolens are manufactured.

Cold water lines run above the textile washers in a fume-filled room where the temperature is 85° and the humidity stays high. It is easy to see what would happen if some sure way were not found to protect the cold water lines against corrosion and condensation. Rusty water would drip on fine woolen piece goods. Stained textiles are spoiled textiles. This danger had to be absolutely eliminated.

Keasbey & Mattison engineering devised the method, and Keasbey&Mattison insulation materials supplied the means of protecting the cold water lines against fumes, heat, and moisture alike. The result is a pipe line that neither corrodes nor drips, and textiles that are safe against rust stains.

The line of Keasbey & Mattison asbestos and magnesia insulation products is complete, and is specialized for the needs of each plant. K&M engineers, working with K&M Distributors strategically located throughout the country, can point the way to real savings in your plant, too. Write Dept. 11 for full details.

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Lifetime Leak-proof Branch "Take-offs" for High Pressure Piping Systems

BONNEY WeldOlets and ThredOlets are the most efficient, most economical and most satisfactory method of providing branch "take-offs" in high pressure systems.

Recommended for all types of piping installations for pressure values equal to those of seamless steel pipe listed for 400 lbs. steam pressure or 1000 lbs. hydraulic pressure with temperatures to 750° F., they have been used to provide branch outlets in a 600 lb., 300° water line; on a 2500 lb. helium piping system; on CO_2 refrigeration piping at 1200 lbs. which was tested in excess of 2500 lbs. Test sections including WeldOlets and ThredOlets have been stressed to 6000 lbs. without failure.

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They eliminate all cutting and forming of the main pipe and branch and no templets are needed. They provide absolutely leak-proof junctions, which because of their patented design, are of full pipe strength and reduce turbulence and friction to a minimum.

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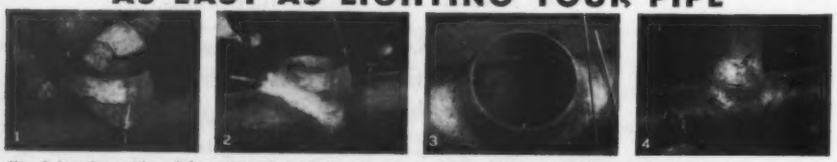
For increased safety and efficiency in your next piping installation get the facts today on WeldOlets and ThredOlets. Write for Bulletin WT29.

AS EASY AS LIGHTING YOUR PIPE



(1)—Select the position of the outlet, rub the fitting over the pipe several times to remove scale, mark center lines and tack the WeldOlet or ThredOlet into position. (2)—The fitting is then welded into place by the electric-arc or oxy-acetylene method. A junction of full pipe strength and a leak-proof outlet is the result. (3)—Where the outlet is 2" or larger, the button should be removed after the welding operation. On small sizes the fitting is used as a templet and the hole is cut in the main pipe first, either with a hole saw, the torch or by drilling. Inspection of the inside of the joint is possible by using WeldOlets and ThredOlets, allowing removal of all scale, welding metal, etc. (4)—The branch line is then welded into position. In the event a ThredOlet is used the branch pipe is threaded and screwed into place.

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such production has forced this almost ideal method of producing oil and gas from the earth. With these new ventures have come new problems. New and dependable methods of appraisal of raw material must be perfected; underground behavior of large gas masses must be better delineated and understood; production and extraction methods must be further improved; ways and means for more accurately measuring high-pressure gas must be found. The marked successes of recycling operations, yielding a production of but a few hundred barrels 2 years ago but now of more than 25,000 barrels, or 1,050,000 gallons daily from more than one billion cubic feet of gas, presage production, in a few years, of perhaps several hundred thousand barrels of almost-motor-fuel-quality condensates. This prospect, influencing the controlled production of crude oil in an amount equal to more than twice the distillate or condensate recovery effected because of its near-gasoline quality, is alarming proration experts and regulatory bodies and thus apparently the greatest problem of all is introduced: Should recycling production be controlled and, if so, how much? All of these questions in one way or another, in my opinion, affect the natural gasoline industry. Our association is joining in the solution of problems of recycling and I exhort our members to participate generously in the work.

Variety of Products

"Chemical means have been found for producing almost an endless variety of products from natural gas. Aside from the more familiar gasolines, liquefied petroleum gases, and the lately reformed superior fuels for internal-combustion engines, solids, lubricants, solvents and many new raw materials for the chemical industry have been made available. Even methane may be converted, although not yet commercially so, to usable liquid fuel by pyrolysis, and there is indication that weight yields of conversion of natural gas components of almost 100 percent are not unreasonable. The prospect of gas potentiality is astounding! A million cubic feet of average natural gas weighs 28.3 tons and a glance at the statistics for last year reveals that the natural gas production of the country, by such means as described, could have met all the motor-fuel requirements of the country. Saying it in another language, not one barrel of crude oil would have been necessary had all the natural gas yielded, by extraction and conversion, its potentially available liquid fuels.

"All of these considerations point us, in our industry, to new and revolutionary discoveries and undertakings, if we are to persist. No one is going to bring us, full blown, the solutions to our problems or present us the plan of action. As we see the former utility of natural gasoline, based on its inherently superior qualities, depressed by the advances in motor-fuel technology and adaptations, we ourselves, must conceive and make the moves vital to sustenance.

"I can not overlook a line of commendation for our program committee and our secretary who have arranged this session of our association for you. I am sure, at the end, you will agree as to the merit of the program and the excellent quality of the talent appearing. Without detailing all the considera-

THE TUBE THAT REPAIRED ITSELF

AND DOUBLED ITS LIFE

Well-known is the ability of copper and its alloys to form, under the right conditions, protective films which can repair themselves when broken.

Analyzing such reactions — obtaining *the right metal for the job*— is part of the 3 services Scovill offers its customers: service in *men*, in laboratory-controlled *metals*, and in *manuals* for easy reference. Pictures on this page show these services in action.

Problem — Corroded tubes like this were costing a large oil refinery replacements every 8 months. A Scovill consultant, called in, found Admiralty tubes operating in vapor-side temperature, of 210°F., with a permeable scale formation favoring dezincification. Contaminated salt to brackish circulating water was used for cooling.

Solution — Back to Scovill's laboratories went the facts and figures. "At 210°F., recommend 70-30 Cupro-Nickel," said the laboratory men. An inquiry later developed the fact that these tubes lasted 16 months without a failure — a 100% increase in service life.

Reason — the 70-30 Cupro-Nickel tubes had formed a protective film out of their own corrosion products, a film that repaired itself—thanks to Scovill's accurate analysis of the chemical reactions involved.

Now It's In This Booklet — Cases like this, covering all varieties of heat exchanger conditions, are the backbone of Scovill's "Condenser Tubes" booklet. Subsections devoted to the corrosion of metals and alloys... may include equally valuable cost-saving hints for *you* ... a copy of this booklet is available upon request. Address Scovill Manufacturing Company, 15 Mill Street, Waterbury, Connecticut.

tions which have been before them or the results attained, I wish also to acknowledge the splendidly cooperative work of our several committees. Herein really lies the very life of the association and it is almost shameful not to mention every committee and name every member. I know of no more forceful way in which to express our appreciation of the Natural Gasoline Supply Men's Association than to say it would, indeed, have been like the blow of finding an old friend gone had they not been with us here in keeping with their annual custom. Each of you, partaking of their hospitality, should genuinely express your personal thanks to every member of that group not too busy to listen.

"Now, suggesting you reflect again on the past effectiveness of Natural Gasoline Association of America, reaffirming my own faith in its further accomplishments and reiterating my pleasure in your fine support in the past biennium, I bow out as your President."

Abstracts of all papers and committee reports follow:

Revised Charcoal Testing Method

By H. L. Oder,
Cities Service Oil Company, Chairman N. G. A. A. Gas Testing Committee

This paper reports the progress made during the past year in revising the old charcoal testing code used in determining the natural gasoline content of natural gas. The author outlines committee activities and conclusions which have led to tentative adoption of most of the proposed revisions. According to the report the new edition will give more duplicable results than the previous method since some optional features have been eliminated and tolerances have been reduced. Other work of the committee was also reviewed indicating plans have been made for field studies of methods used in determining the gasoline content and specific gravity of gases under high pressure and obtaining a representative sample of such gases. This work will probably be conducted along the Gulf Coast in the recycling fields and comparative tests will be made with all existing equipment and methods.

Technical Committee Report

By H. H. Beeson,
Sabine Valley Gasoline Company, Vice Chairman N. G. A. A. Technical Committee

In seeking to set up some universally acceptable conversion tables of volume-temperature and gravity-temperature factors for liquefied petroleum gases, the N. G. A. A. Technical Committee has attempted to find the true density values for some pure hydrocarbons. Most of the material previously available was in good agreement for the temperature range above 60° F. but discrepancies were noted below this temperature and became increasingly great with a further drop in temperature.

Most of the experimental work in this project has been done in the laboratories of the University of Tulsa under the direction of Professor W. R. Nelson. Equipment needed was designed by committee members. Not yet completed, these experiments are to be continued though present indications are that satisfactory tables can be made available in the near future.

Another activity of the technical committee was concerned with the development of a hydrometer method for obtaining the specific gravity of liquefied petroleum gases. A tentative code has been completed and some further comparative testing is all that remains to be done before the new method can be presented to the industry. The committee has also developed a new table of physical constants for the paraffin hydrocarbons, incorporating all the latest and most authoritative technical data available.

Safety Standards of The Liquefied Petroleum Gas Industry

By G. L. Brennan,
Phillips Petroleum Company

The sources of liquefied petroleum gas from natural gasoline plants and refineries are briefly discussed with data on the volume and growth of sales made by the Liquefied Petroleum Gas industry. The properties of butane and propane which make them of economic value also present hazards requiring proper design of equipment and safe methods of handling to prevent accidents.

Safety standards of the liquefied petroleum gas industry have been developed from extensive research, testing of equipment and years of experience. The procedures of establishing safe practices and standards through cooperation with regulatory and insurance bodies such as the National Fire Protection Association, Association of American Railroads, Interstate Commerce Commission, and National Board of Fire Underwriters, are reviewed.

Pamphlet 58 of the National Board of Fire Underwriters and regulations of the Interstate Commerce Commission contain the various safety rules and standards used by the liquefied petroleum gas indus-

Officials of the Natural Gasoline Supply Men's Association were elected at the annual meeting in Dallas April 23. Seated are: L. S. Allen, National Tank Company, Tulsa, president; George Probst, Clark Brothers Company, Inc., Tulsa; D. A. Leach, Chicago Bridge & Iron Company, Tulsa, vice presidents; C. D. Peterson, Fisher Governor Company, Tulsa, treasurer.

Standing left to right: William F. Lowe, Tulsa, secretary of this association as well as the Natural Gasoline Association of America; J. H. Satterwhite, Westcott & Greis, Tulsa; A. M. Buxton, Cooper-Bessemer Corporation, Tulsa, and W. W. Woobank, Woobank Pump & Machinery Company, Tulsa, directors. Woobank was president in 1940. V. C. Canter, Frick-Reid Supply Corporation, Tulsa, William Gebo, Ingersoll-Rand Company, R. T. Roberts, Goulds Pumps, Inc., and Ray E. Miller, president of the Natural Gasoline Association of America, are additional directors of the association.

Supply Group Issues Fourth Technical Manual

Along with its customary activity of providing entertainment for each annual meeting of the Natural Gasoline Association of America the Natural Gasoline Supply Men's Association distributed its fourth Technical Manual at the twentieth meeting of the former association in Dallas, April 23, 24 and 25. The manual has been enlarged for its fourth printing. It went to all who registered at Dallas. During the year it will have distribution to the petroleum industry through facilities of the Natural Gasoline Association of America.

Entertainment provided for the Dallas meeting was confined to the evening of April 24, when a buffet supper, musical entertainment and a floor show were combined.

The annual meeting of the supply association was held the morning of April 23. Reports of officials and committees were heard and officials and directors were elected.

Something new for the association was the consideration given to the scarcity of some metals essential to equipment for gasoline plants. The following from the minutes of William F. Lowe, secretary, shows this trend:

"After some discussion of the need for and the difficulty of obtaining certain metals for the manufacture of important equipment and instruments, it was unanimously agreed that the board of directors of the Natural Gasoline Association of America be requested to make every effort to obtain priority orders for such metals. The secretary was directed to carry this resolution to that body and to represent the Natural Gasoline Supply Men's Association in the discussions of the problem."

What Alloy for Condenser and Heat Exchanger Tubes?

To obtain maximum service life for condenser tubes there are many operating factors to be considered—character of the cooling water, turbulent flow, and entrained air, to name but a few. Naturally your tube alloy should be selected in accordance with the combination of these factors existent in your plant.

Through their unparalleled experience in the field, Anaconda engineers have accumulated a vast fund of knowledge with which to meet these problems. Their service is available upon request. They can cooperate in analyzing your requirements and place before you performance records of copper alloys under similar operating conditions. No charge is made for such consultation. 41118

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try. Some of these basic rules are mentioned in detail to point out the possibility of accidents if they are ignored.

Suggestions are offered as to how the natural gasoline industry may help in maintaining the fine safety record now established in the transportation and handling of the products of this young and growing industry.

The Magnitude of Variables Affecting Accurate Reid Vapor Pressure Determinations

By F. M. Allen,
Indian Territory Illuminating Oil Company.

Recent elaborate laboratory tests conducted by several oil company representatives on the N. G. A. A. Technical Committee have resulted in some interesting and significant discoveries with respect to the use of the 100° F. air chamber in making Reid-vapor-pressure tests with all grades of gasoline. Under definitely controlled conditions, the experiments proved the existence of previously unknown sources of error in vapor-pressure determinations having a magnitude ranging from .1 to .8 pounds. These experiments are given in detail and the conclusion is drawn that only under the most exacting conditions can real accuracy be obtained with the 100° F. air chamber. For most consistent results it was recommended that tests be conducted at temperatures approximating those of the laboratory. Other sources of error in the Reid method were also discussed.

Low Temperature Fractional Analysis, Apparatus and Procedure

By H. A. Montgomery and C. E. Wharton,
Hanlon-Buchanan, Inc.

During the past year the laboratories of 15 large oil companies have been cooperating in a joint project sponsored by the N. G. A. A. Technical Committee for the study of fractional distillation apparatus and procedure. The work consisted of the exchange of identical gas samples and a comparison of results obtained in the different laboratories on the same sample. The resulting data and its correlation are voluminous and have brought to light some interesting and enlightening information. It is evident that some standardization of apparatus would be in the interest of accuracy and duplicability of results but the major group of errors seems to have centered in the technical ability or knowledge of the laboratory operators. It is probable that a manual for standard procedure would reduce the errors from this source. Up to the present time only natural gases have been analyzed but the committee now has under consideration some experiments with synthetic gases of known components. As with the natural gases, however, such gases would be circulated for analysis with no advance information on their characteristics. The project will be continued with a view to general standardization.

Close Fractionation in the Manufacture Of Special Products at Natural Gasoline Plants

By H. W. Harts,
Warren Petroleum Corporation

Abnormally low prices and declining income experienced by the natural gasoline industry the past few years have caused several manufacturers engaged in this phase of the oil business to seek additional revenue through any economically feasible secondary operation connected with the manufacture of the various grades of natural gasoline.

First came propane and butane, the two related products which either were cut separately or in some cases merely considered as a conglomerated overhead, and which were sold for any of the various uses to which are put the liquefied petroleum gases.

As the market began to absorb these two closely related components the manufacturers sought still additional income by making preparations for the isolation of various isomers which occur in relatively small quantities in practically all natural gas.

The increasing demands made upon refiners for high-octane motor fuels, and the new manufacturing processes installed by the refiners and which necessitated the use of the isomers, combined to create an immediate demand which was met by the natural gasoline manufacturers as, one by one, they installed equipment to manufacture iso-butane and iso-pentane.

The iso-pentane, being an integral part of an extremely desirous part of the natural gasoline, has not been isolated as extensively as the iso-butane, which previously had been either a waste product or a filler in the butane-propane mixtures.

The iso-butane suddenly acquired a very considerable value with a ready market, due to the various new refining processes. The manufacture of this product, however, was not the very simple fractionation necessary in the case of butane-propane. Extremely expensive equipment and accurate control were necessary, so that the return on the investment was not the desirable picture that had been indicated at first glance. This was due not only to the cost of installation and operation of manufacturing equipment, but also to the cost of storage, transportation and testing. The mere fact that the specifications were so exacting necessitates low temperature fractionation on each shipment made, and the slightest deviation in the tower control may conceivably and easily throw the entire storage off specifications.

This paper deals, therefore, with the installation, operation and cost of equipment and the expected return on investment for the manufacture of iso-butane and iso-pentane.

ALOIS KREMSER

Recipient of the Hanlon Award at the twentieth annual meeting of the Natural Gasoline Association of America was Alois Kremser, assistant manager of research, Standard Oil Company of California, San Francisco. His is the fifth name to be added to the plaque,provided by E. I. Hanlon, chairman of the board of the Hanlon Companies, Tulsa. In addition to this honor he was presented with a gold watch and emblamatic chain, also the gift of Hanlon.

Kremser is a native of Austria and a graduate of the University of Vienna in 1912. After teaching there he followed mechanical engineering in Japan until the outbreak of the first World War when he came to the United States. He joined the research staff of Standard Oil Company of California in 1922.

In presenting the award George P. Bunn, association president said:

"To your original formula for analyzing mathematically the operation of the absorption process, we owe much of our present understanding of stripping, rectification and heat transfer, all of which are fundamental elements in the production of natural gasoline and liquefied petroleum gases."

Making Gas Measurements Balance in a Cycling Plant

By D. A. Sillers,
Lone Star Gas Company

Measurement of high-pressure gas introduces a number of special problems, both in the field and office, concerned with the checking of plant gas measurement. The author shows how these problems were met in obtaining a check on gas flow within 1 percent. Meter installation problems from the christmas tree on the well head through the plant to the input wells are discussed in detail, including such features as: meter run design, meter piping, seal pots, prevention of freezing, sizing of meter runs, and design of input well installations. Among the office problems covered are: new coefficients required for thick wall and odd size pipe, seal-pot factor and factors for supercompressibility, temperature and gravity. The author outlines a simplified method for applying the method and formula of Dr. G. G. Brown, University of Michigan, for solving high-pressure-gas flow and plant problems. The paper concludes with a discussion of the economic importance of accurate gas measurement.

Dehydration in High Pressure Gas Operations as Applied to Repressuring and Pressure Maintenance

By R. A. Carter,
Continental Oil Company

Most of the literature covering the formation and disposition of hydrates deal with the operation of commercial gas lines over considerable distances, but this paper confines itself to the discussion of problems introduced by hydrate formation in the lines around a recycling, or high-pressure-gas plant. The writer reviews the known methods of reducing or eliminating the formation of hydrates and points out the limitations of each. Many of the accepted methods are illustrated and several new methods are outlined, following which a review of the cost of such operations is presented. According to the author the operation of hydrating systems using solid material such as activated alumina or liquids such as diethylene glycol is economical when installed in a repressuring

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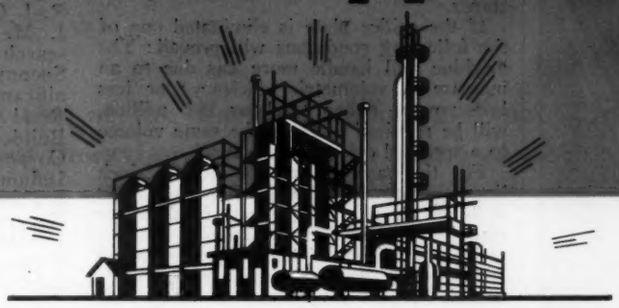

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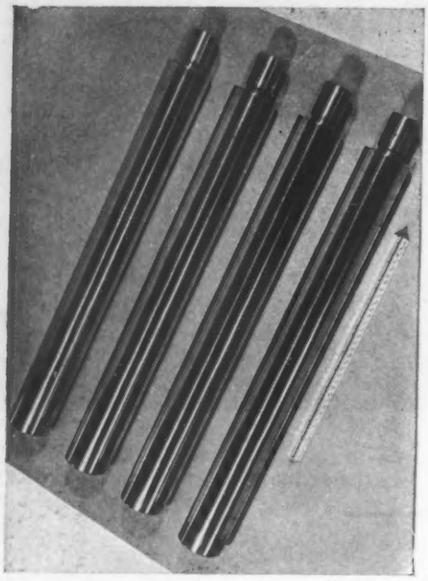

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Compressor Losses Caused by Orifice Meters

By J. G. Burnham and V. E. Middlebrook,
Shell Oil Co., Inc.

The effect of an orifice inserted in a line carrying gas will be to produce a final downstream pressure which is lower than the upstream pressure.

In the case of an orifice meter, which is usually installed relatively close to the compressor suction header, the final downstream pressure will be essentially the intake pressure of the machines. If there were no orifice in the line the upstream or higher pressure, not the final downstream pressure, would be the intake to the machines.

If the orifice plate is eliminated one of the following conditions will prevail: The machine will handle more gas due to an increase in volumetric efficiency; or less horsepower, either total or per million, will be required to boost the same volume to a specified discharge pressure.

For the case given here, of a 12-inch line carrying 3000 MCF of gas available at 8-inch vacuum, the percent of volumetric capacity lost will range from 1 percent at 5 inches differential to 15 percent at 50 inches. The percent increase in HP/MMCF required to boost to 40 pounds varies from about 1 percent at 5 inches to 11 percent at 50 inches.

If the orifice is removed from the master meter the total incoming gas volume can be determined by two meters; one installed on absorber residue, the other on the stabilizer tops. A factor calculated from a fractional analysis of the finished product may be used to convert the gallons of stabilized gasoline to equivalent cubic feet of gas. The total of the two metered volumes plus the factored volume will equal the volume of gas entering the plant.

Myers Urges Combat of Occupational Diseases

J. Howard Myers, director of safety for The Atlantic Refining Company, urged both labor and industry to take vigorous stands against occupational diseases before the Safe Practice Conference in Philadelphia May 1. The conference was sponsored by the Pennsylvania State Department of Labor and Industry. He said:

"Industry and labor cannot deny that uncontrolled occupational diseases are both costly and needless. They are costly to both in loss of production, earnings, and health, and needless because, with employer and employe cooperation in the use of available health conservation knowledge, they may be controlled.

"In these days, interrupted production is unpatriotic because it breaks down the orderly flow of defense materials to the government. With our present economic interdependence, a company need not be working directly on a government contract for its products to be considered essential to the national defense. And at any time loss of individual effort, earnings, and health is economically unjustifiable."

Wilson to Address SAE Summer Meeting

Dr. Robert E. Wilson, Office of Production Management and president of Pan-American Petroleum and Transport Company, will discuss "Petroleum and the War" before the summer meeting of the Society of Automotive Engineers at White Sulphur Springs, West Virginia, the evening of June 4. The meeting will begin June 1 and continue through June 6. He will evaluate the status of this country as well as of belligerent countries as to the supplies of petroleum.

The meeting will have two sessions on fuels and lubricants, June 5 and 6.

Walter G. Ainsley, Sinclair Refining Company, will discuss "Evaluation of Diesel Fuels in Full Scale Engines," on the first day, while B. E. Sibley, Continental Oil Company, will discuss "Review of Temperatures—Road Test Engines." The program for the second day will cover: "1940 Road Tests," by R. J. Greenshields, Shell Oil Company; J. M. Campbell, General Motors Research Division, and W. M. Noladay, Socony-Vacuum Oil Company; "Significance of the 1940 CFR Centralized Road Test Technique to the Engine Builder," by W. E. Drinkard, Chrysler Corporation; "The Ignition System as Influenced by Fuel Characteristics," by J. T. Fitzsimmons, Delco-Remy Division, General Motors Corporation, and "A Proposed Method for Duplicating Road Octane on the Multi-Cylinder Engines in the Laboratory," by J. A. Moller, The Pure Oil Company.

CNGA Sports Frolic To Be Held June 7

The annual sports frolic of the California Natural Gasoline Association will be held June 7 at the Riviera Country Club, Santa Monica. H. E. Leedy, Crane Company, is chairman of the program committee. Golf matches will start in the morning. In the afternoon there will be a baseball game between Majors and Independents, volley ball, horse shoe pitching and badminton. The evening program will include a banquet and a special show.

Other members of the committee on arrangements are: Gordon Greene, Robinson Orifice Fitting Company; Walter Landis, Crane Company; George Christian, Crosby Steam Gage & Valve Company; Glenn Gill, J. B. Gill Company; Harry Fiske, Ingersoll-Rand Company, and Harold Dresser, Fluor Corporation.

LPG Program for Plant Personnel

The program for the second annual meeting of the Liquefied Petroleum Gas Association, Pacific Coast Section, San Francisco, June 9-10, has been prepared in the interest of men from natural gasoline and refining plants. They have been especially invited to attend the sessions by Charles E. McCartney, chairman of the sponsoring organization.

Along with this meeting there will be held the second Pacific Coast Liquefied Petroleum Gas Exposition.

Of especial interest to men in manufacturing will be a paper by C. L. Parkhill, Parkhill-Wade Company, Los Angeles, on "A Survey of the LP Gas

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Internal Combustion Engine Market," and a paper on "Physical Properties of LP Gases," by Max B. Anfenger and O. W. Johnson, safety engineers for Standard Oil Company of California.

Oil Supply for Defense Sufficient

Speakers before the spring meeting of the National Petroleum Association, Cleveland, April 24 and 25, expressed opinions that the supply of oil in the United States is ample for national defense and war. E. De Golyer, Dallas consulting engineer, said the industry might have an average increase of 20 percent in demand for 1941, with heavy fuel the leading product.

"The industry," he said, "is able to meet this demand with ease. What the future requirements may be is less definite, but it is possible that demand may increase in an upward spiral and, even now, we should be taking thought for the possible expansion of our present facilities. It is not difficult to see future annual requirements at the rate of 200,000,000 barrels of aviation fuel alone."

P. M. Robinson, assistant to Dr. R. E. Wilson in the Office of Production Management, Washington, said indications were that lubricating oil demand would be up 2.25 percent during the next fiscal year. This, he pointed out, will be but little more than half the reduction in lubricating oil exports last year.

N. H. Weber, association president and vice president of The Pure Oil Company, Chicago, expressed the opinion that there will be no federal control of the industry unless the nation engages in a shooting war.

AGA Natural Gas Division Meets

Conferences on subjects of interest to the natural gas industry were outstanding parts of the annual meeting of the Natural Gas Division of the American Gas Association in Dallas, May 5-7. The subject of transmission made up the program of May 6 and there was an accident prevention meeting the same day.

Two general sessions were held, one May 5 and one May 7. Luncheon meetings were held May 6.

H. D. Hancock, New York, chairman of the Natural Gas Section and president of Gas Advisers, Inc., presided at the first general session. J. French Robinson, president of the East Ohio Natural Gas Company, presided over the second general session. D. A. Hulcy, Dallas, president of Lone Star Gas Company, delivered the address of welcome.

Conference Hears Plastics Discussion

Oil as a source of plastics and chemicals was among the subjects heard at the annual Petroleum and Natural Gas Conference at Pennsylvania State College, May 2 and 3. "Plastics and Chemicals from Natural Gas," was the subject of R. L. Wakeman of the Mellon Institute, Pittsburgh.

"The Liquefication and Storage of Natural Gas to Date," was reviewed by Dr. R. W. Miller, Peoples Natural Gas Company, Pittsburgh.

Defense Dominates W. P. R. A. Program

Relationship of the petroleum industry to preparations for national defense was the foremost theme of the annual convention of the Western Petroleum Refiners Association, Hot Springs, Arkansas, April 16, 17 and 18. As usual there were subjects of technical nature.

All officials were re-elected: C. L. Henderson, Vickers Petroleum Company, Wichita, president; R. W. McDowell, Mid-Continent Petroleum Corporation, Tulsa; C. W. Cahoon, Jr., Olney Oil & Refining Company, Wichita Falls; T. M. Martin, Lion Oil Refining Company, El Dorado, Arkansas; and H. E. Zoller, Derby Oil Company, Wichita, vice presidents; John C. Day, Tulsa, secretary; and Mary Sue Collins, Tulsa, treasurer.

Men added to the directorate are: T. A. Helling, El Dorado Refining Company, El Dorado, Kansas; P. E. Lakin, Shell Oil Company, Chicago; Paul Ryan, National Refining Company, Cleveland and Rex H. Winget, Cushing Refining & Gasoline Company, Cushing.

Those re-elected to the directorate are the president, the four vice presidents and H. T. Ashton, Lubrite Division, Socony-Vacuum Oil Company, St. Louis; Paul G. Blazer, Ashland Oil & Refining Company, Ashland, Kentucky; H. W. Camp, Cities Service Oil Company, Bartlesville; Sheldon Clark, Sinclair Refining Company, Chicago; O. L. Cordell, Bareco Oil Company, Tulsa; A. Danciger, Danciger Oil & Refineries, Tulsa; A. M. Hughes, Phillips Petroleum Company, Bartlesville; R. R. Irwin, White Eagle Division, Socony-Vacuum Oil Company, Kansas City; R. E. Luton, Ohio Oil Company, Robinson; F. L. Martin, Sunray Oil Company, Tulsa; W. E. Moody, Deep Rock Oil Company, Cushing; I. A. O'Shaughnessy, Globe Oil & Refining Company, Minneapolis; L. H. Prichard, Anderson-Prichard Oil Corporation, Oklahoma City; W. G. Skelly, Skelly Oil Company, Tulsa; J. W. Warner, Tide Water Associated Oil Company, Tulsa; C. B. Watson, Pure Oil Company, Chicago; J. A. Welch, Arkansas Fuel Oil Company, Shreveport; L. B. Simmons, Rock Island Refining Company, Duncan.

Dow on Political Situation

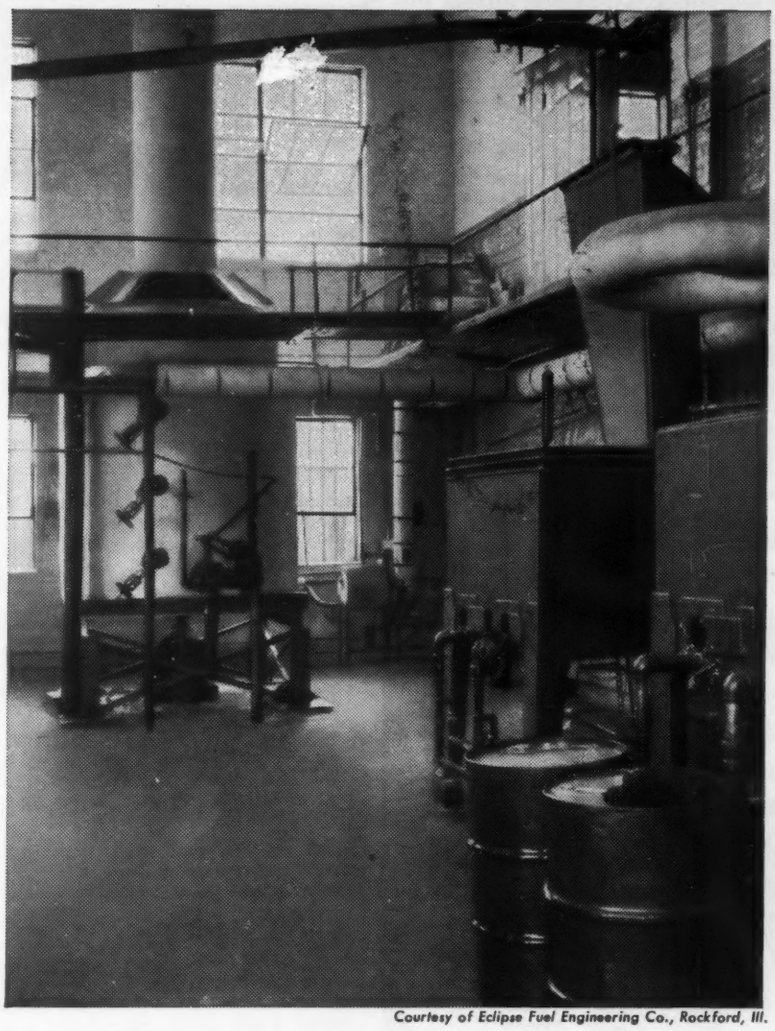
In analyzing political affairs Fayette B. Dow, Washington Counsel of the association, outlined the unsettled state in the capitol and added:

"Only a little while ago we were going to defend the Western Hemisphere. Then the President, although addressing our own Congress, spoke to the whole world. In order for democracy to succeed here, the four freedoms—freedom of speech, freedom of worship, freedom from fear, freedom from want—must be established everywhere. But the President does not always use his own voice in the expression of the official viewpoint. The vice president said last week that 'the American people are ready to go to war if their rights are transgressed at any vital point.' These rights, he said, include aiding the fighting democracies 'to the limit with planes, ships, munitions and feed.' He warned against overconfidence in the United States. He said, 'we are not working hard enough. We do not realize that our very lives are at stake and that speed

CORE OIL PROCESSING

with DOWTHERM

THE HIGH TEMPERATURE, LOW PRESSURE, HEAT TRANSFER MEDIUM



Courtesy of Eclipse Fuel Engineering Co., Rockford, Ill.

THE CONVERSION OF THIS SYSTEM TO DOWTHERM—

1. Eliminated delays and shutdowns due to fires and the necessity for replacing kettle bottoms.
2. Made available a superior product.
3. Cut processing time 50%.
4. Reduced fuel costs 50%.

Over six years ago, a Midwestern refinery decided to install a Dowtherm* heating system to replace the obsolete direct-fired core oil processing equipment in their Specialty Department. A 1200-gallon kettle, jacketed in three sections and heated by Dowtherm vapor, was used in the new system—an arrangement which allowed varying sized batches to be processed.

The installation of the Dowtherm system eliminated the "charred kettle bottom" problem with its attendant fire hazards. . . . It insured the production of a superior product since under its controlled temperature conditions it prevented the formation of decomposition products. . . . Its inherent flexibility simplified processing problems ordinarily encountered in handling varying sized batches under varying temperature requirements.

This installation is one of over 200 units that are satisfactorily solving high temperature industrial processing problems. The proven record and ability of the Dowtherm high temperature, low pressure method of heat transfer merits your consideration.

*Trade Mark Reg. U.S. Pat. Off.

THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

New York, St. Louis, Chicago, Seattle, San Francisco, Los Angeles

Working with you for America

now may make the difference of millions of lives in this hemisphere.'

"If I interpret correctly the swiftly moving progress of events we have abandoned neutrality in spirit if not in name. We have a 'Defense Program' but we have already gone half the distance between defense and a shooting war. Whether a nation can go that far and stand still is a question for which Washington today feels, even if it does not say, that it knows the answer.

"Immediately behind us, as you know, are eight years during which the Federal Congress has placed on the statute books and the courts have upheld a series of laws—some aimed at reform, some aimed at recovery, some aimed, I suspect, just at control. In that period down to the first of this year we have endeavored through our daily bulletins and through a growing volume of correspondence with the members of this association to keep you informed of the obligations imposed by these laws. They have involved such old subjects as taxation, such newer subjects as wage-hour requirements and more recently government purchases, export controls and priorities. It has been a factual, interpretative and a legal service. With about half the staff as before the work has been steadily growing and with a clear memory of World War days I know what the Washington office has before it. We went into World War I a nation of largely free enterprises but with the immediate background of eight years of unprecedented peacetime controls, we are gliding rapidly and without protest into a regimentation that is likely to be more far-reaching than the business life of this country has ever known before. The structure of control has been building up gradually, just as our approach to a positive position in the war has been gradual. That structure has not approached its final form. We have had the Council of National Defense, the Advisory Commission to that council, we have the Office of Production Management and its higher control, the Office of Emergency Management whose door opens into the White House.

"There is not sufficient time allotted to me to discuss those successive steps taken by presidential decree but last Friday there appeared 'Executive Order Establishing the Office of Price Administration and Civilian Supply in the executive office of the President and defining its functions and duties.'"

In an extemperaneous discussion of authority thus far granted for price control, Dow said he believed that prices could be controlled, under existing laws, only on purchases for military and defense projects. He read at length from a recent article on the subject by Bernard M. Baruch.

Other speakers on the broader aspects of industry and its relation to government and national defense were: Willard Chevalier, publisher of Business Week, "Business Under Arms"; Paul G. Hoffman, president of the Studebaker Corporation, "Repositioning Business for All-Out Defense"; Henry M. Busch, Western Reserve University, "America in a World at War."

Technical Sessions

Technical subjects were confined to sessions April 17 and 18 with "Modern Trends in Lubrication," William H. Oldacre, D. A. Stuart Oil Company, Chicago; "Trends in Lubricating Oil Manufacture and Utilization," Malcolm H. Tuttle, Max B. Miller Company, New York; "Carbon as a Material of Construction for the Petroleum Industry," M. J. Dorcas, National Carbon Company, Cleveland; "Synthetic Rubber," I. E. Lightbown, Standard Oil Development Company, New York.

R. W. McDowell, vice president of Mid-Continent Petroleum Corporation, Tulsa, have a review of the petroleum industry since 1939.

At the suggestion of members interested in asphalt manufacture, directors passed the following resolution:

"That the officers, directors, members and non-members should now more than ever before recognize that petroleum asphalt is one of the most valuable and permanently useful products to be produced from crude petroleum and that each individual should take it upon himself to become more fully informed as to the superior uses of petroleum asphalt for permanent low-cost construction of highways, airports, naval bases and army camps to the end that the American public may reap the benefits of a wider use of asphaltic products and enjoy the economic benefits and that the petroleum industry may, in making this better contribution to the public welfare, bring benefits to all branches of the petroleum industry that to some extent have heretofore been entirely overlooked, thereby cooperating and aiding in a greater American defense movement."

Bear Brand

GREAT WESTERN DIVISION • BEAR BRAND PRODUCTS • THE DOW CHEMICAL COMPANY

DOW

CHEMICALS INDISPENSABLE TO THE REFINING INDUSTRY

BEAR BRAND chemicals, manufactured by the Great Western Division of The Dow Chemical Company, from western materials by western labor, find universal favor among refiners.

The superb technical facilities of Great Western produce these chemicals under strict laboratory control. The purity and immediate availability of BEAR BRAND chemicals are accepted without reservation by western refiners—by refiners everywhere.

GREAT WESTERN DIVISION • THE DOW CHEMICAL COMPANY
San Francisco, California • PLANT: Pittsburg, California
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CAUSTIC SODA, NaOH
Supplied in 3 forms:
Liquid: Colorless, semi-opaque viscous solution.
Solid: Dense, white, opaque, deliquescent solid.
Flake: Thin, white, opaque deliquescent flakes, practically free from dust.

ANHYDROUS AMMONIA
NH_3
Colorless gas with extremely pungent odor at normal temperatures and pressure. Liquefies at −33.4°C. at atmospheric pressure. Specific gravity at 0°C. and one atmosphere 0.596; boiling point −33.4°C.

CAUSTIC POTASH, KOH
In three forms. Liquid: Colorless to dark, somewhat opaque, viscous solution.
Solid: Dense, dark, opaque, deliquescent solid.
Flake: Dense, dark, opaque, deliquescent flakes, practically free from dust.

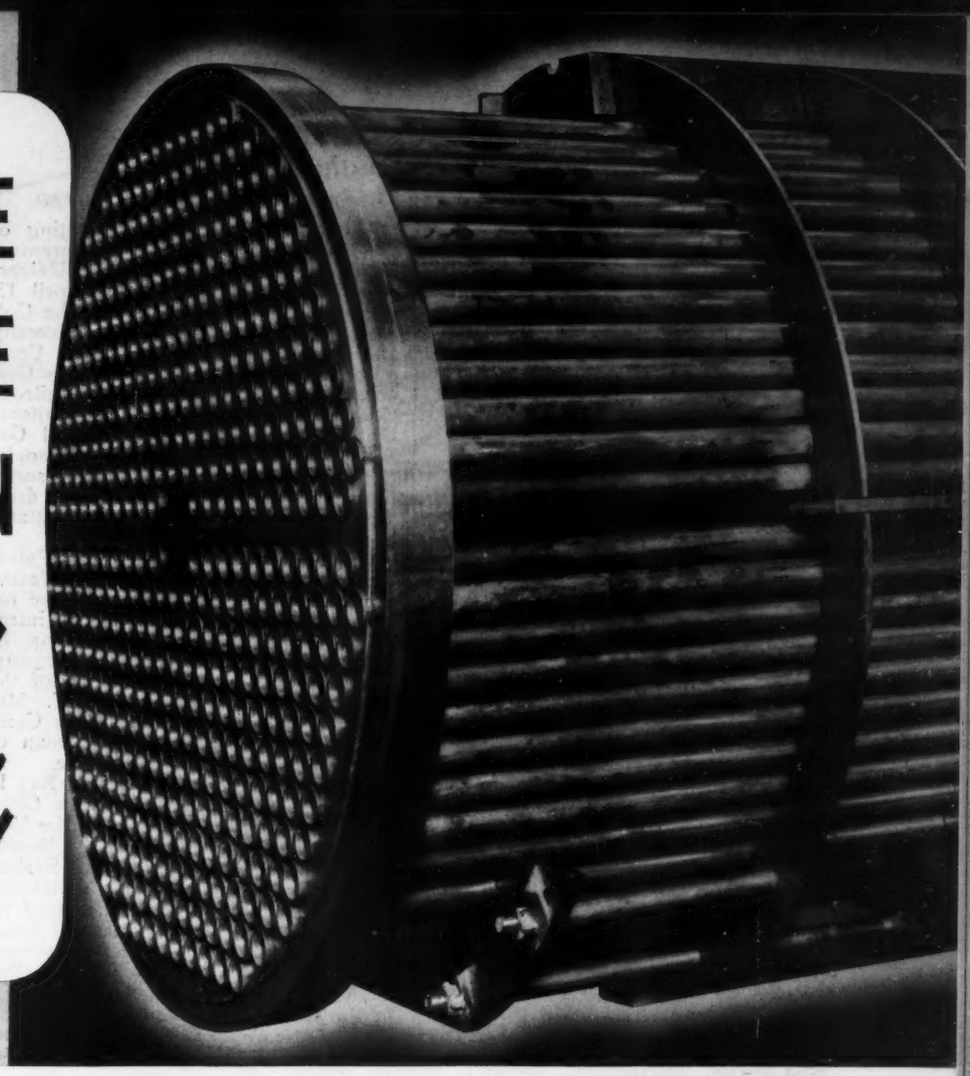
AQUA AMMONIA
NH_4OH
Colorless, clear solution with pungent ammonia odor. Specific gravity at 15°C. . . . 0.89; Baumé 26° . . . −26.5°. Freezing point, below −40°F.

SULPHUR DIOXIDE
SO_2
Colorless gas at normal temperatures and pressure, liquefies at −10°C. at atmospheric pressure.

LIQUID CHLORINE
Cl_2
Liquefies at −34.6°C. at atmospheric pressure. Not over 1.4 lbs. moisture per ton. Total residue not over 15 grams per 100 lbs.

HERE'S WHERE YOU'LL FIND THE DIFFERENCE IN TUBES

and what a difference!



When the expanding tool meets the tube end — when you're rolling in and beading over to obtain a tight, lasting joint—that's when you'll notice the big difference in heat exchanger tubes.

If the tubes are Republic ELECTRUNITE, you'll experience the ease of rolling which results from consistent uniformity in diameter, wall thickness, concentricity and ductility. You'll find that tube after tube rolls evenly and smoothly all around the wall. You won't need to change expanding tools due to variance in wall. You'll get tight joints that do not weep under pressure. And you'll get them quickly — with less rerolling — which means lower installation cost. Users report as much as 30% savings.

Ease of fabrication—made possible by the high uniformity resulting from electric resistance welding process of tube manufacture—is a very good reason for using Republic ELECTRUNITE Heat Exchanger Tubes. But other advantages are important, too. They slide through holes in header sheets without difficulty. The smooth, scale-free surface inhibits corrosion—lengthens service life. There is no scale to work loose and eventually clog lines and valves. Every tube is safe and sound — tested under hydrostatic pressure before shipment.

Republic ELECTRUNITE Heat Exchanger Tubes are made of carbon or stainless steel—in sizes from 3/8 to 5-inch — and in various gauges. Let us tell you more about the difference in heat exchanger tubes — and what it can mean to you. Write to Steel and Tubes Division, Republic Steel Corporation, Cleveland, Ohio.

REPUBLIC STEEL — DEFENSE FOR AMERICA

*Reg. U. S. Pat. Off.

REPUBLIC

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ELECTRIC RESISTANCE WELDED STAINLESS STEEL TUBING

Also Boiler Tubes • • • Condenser and Heat Exchanger Tubes • • • Mechanical Tubing

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The advice and suggestions in this useful repair manual are based on enthusiastic reports which engineers all over the country have been sending us for 45 years describing hundreds of ways in which Smooth-On has helped them to save time, labor, and money on repair jobs all over the plant.

Some of the subjects covered:

How to seal cracks in casings or shells of pumps, heaters, condensers, evaporators, tanks, engines, valves, etc.

How to stop leaks at seams, bolts, rivets, threaded or flanged joints, etc.

How to tighten loose parts of apparatus, fixtures, etc.

How to waterproof concrete, brick or stone floors, walls, cisterns, etc.

How to improve the appearance of rough or blemished machinery bases and other castings

How to make up leak-proof pipe joints

Smooth-On is easy to use, requires no heat, special tools, dismantling of equipment or previous experience, and assures lasting repairs. Smooth-On applications cost but a few cents and save lengthy repair jobs and frequently expensive replacements of apparatus. Buy a can of Smooth-On No. 1 without delay so you will be prepared for emergency repairs and routine maintenance jobs.

Be sure to send TODAY for the 40-page Smooth-On Repair Manual. Your copy sent FREE if you return the coupon.

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Get Smooth-On No. 1 in 7-oz., 1-lb. or 5-lb. can or in 25-lb. or 100-lb. keg from your dealer, or if necessary from us. For your protection, insist on SMOOTH-ON, used by engineers and repair men since 1895.

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Southwestern Gas Measurement Short Course

The seventeenth annual meeting of the Southwestern Gas Measurement Short Course was held at the University of Oklahoma, Norman, April 15, 16 and 17, 1941. Sponsored by the College of Engineering of the university and asisted by the Corporation Commission of Oklahoma, the Kansas Corporation Commission, the Railroad Commission of Texas, the Oklahoma Utilities Association, the Natural Gas Section of the American Gas Association and the Natural Gasoline Association of America, the Short Course drew a record atendance of 705 from 23 states and Mexico.

G. W. McCullough, Phillips Petroleum Company, Bartlesville, was elected chairman of the general committee for the 1942 short course and was introduced at the final assembly. Max K. Watson, Canadian River Gas Company, Amarillo, was elected chairman of the program committee, and E. C. McAninch, Oklahoma Natural Gas Company, Tulsa, was chosen chairman of the practical methods committee.

During the opening assembly, Ray L. Rountree, United Gas Pipe Line Company and general chairman of the 1941 short course, presented W. L. Woodward, president of Zenith Gas System and vice president of the Oklahoma Utilities Association, who introduced W. H. Carson, dean of the College of Engineering of the University of Oklahoma, for an address of welcome. T. J. Strickler, vice president and general manager of Kansas City Gas Company and president of the American Gas Association, discussed the "Gas Industry and The Job Ahead." Following the introduction of the members of the general committee and a report by R. M. Scofield, Lone Star Gas Company and chairman of the practical methods committee, William F. Lowe, secretary of the Natural Gasoline Association of America, and E. H. Poe, secretary of the Natural Gas Section of the American Gas Association, addressed the assembly.

The assembly of the second morning was devoted to discussions of "Fundamental Principles of Orifice Meters," by A. D. MacLean, Pittsburgh Equitable Meter Company, and "Fundamental Principles of Displacement Meters," by A. F. Benson, American Meter Company. During this assembly cash awards for prize papers on "What I Learned at the 1940 Gas Measurement Short Course" were announced and distributed to the following:

First Prize—Miss Sibyl McKay, Victor Gasoline Company, Tulsa.

Second Prize—R. O. Cox, Lone Star Gas Company, Dallas.

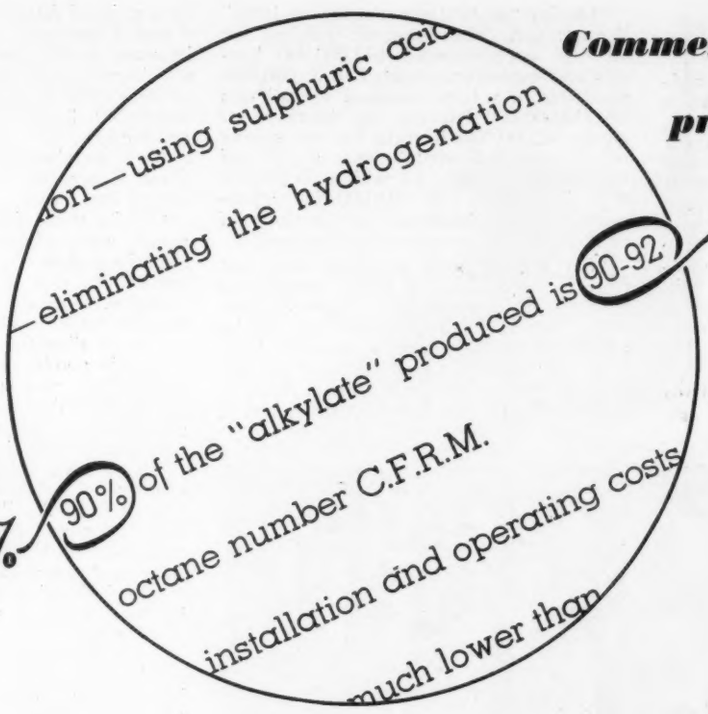
Third Prize—B. H. Fowler, Phillips Petroleum Company, Bartlesville; J. J. Hickey, United Gas Pipe Line Company, Beeville, Oklahoma; George W. Smith, The Gas Service Company, Joplin, Missouri; Herman C. Cowdery, Cities Service Gas Company; J. B. Reidhimer, Arkansas-Louisiana Gas Company, El Dorado, Arkansas.

During the general assembly of the third morning, "Fundamental Principles of Regulators" was discussed by K. R. D. Wolfe of Fisher Governor Company. Andrew F. Schoeppel, chairman of the Kansas Corporation Commission, addressed the assembly on "As a Commissioner Views It."

Classes were conducted during the three afternoons by representatives of the university faculty, equipment manufacturers and various gas, gasoline and oil companies. These class-room discussions dealt with subjects of equipment, field operations and office procedure pertaining to the measurement and regulation of gas. Included in the program were classes on "Functions of Field Meter Men," by J. R. Bird, United Gas Pipe Line Company; "Problems of Elementary Gas Laws," by E. F. Dawson, the University of Oklahoma; "Measurement and Regulation from Extremely High-Pressure Gas Wells," by S. H. Smith, Jr., Lone Star Gas Company, and J. C. Dennis, Tide Water Associated Oil Company; "Field Testing and Maintenance of Large Cacacity Displacement Meters," by J. P. McCarthy, Oklahoma Natural Gas Company; "Operation of Flow Calorimeter," by L. H. Cherry, the University of Oklahoma; "Gas Accounting—Wet Gas Practices," by C. L. Quast, Sinclair Prairie Oil Company; "Pilot-Operated Regulators," by E. C. McAninch, Oklahoma Natural Gas Company; "Problems of Wet Gas Measurement and Regulation," by M. S. Fales, Phillips Petroleum Company, and C. L. Baker, The Texas Company; "Operation and Maintenance of Orifice Meters," by E. C. Terrell, Southern Natural Gas Company; "Determination of Pressure Drop," by R. J. Sullivan, Humble Oil & Refining Company; "Odorization of Natural Gas," by R. M. Scofield, Lone Star Gas Company, B. F. Worley, United Gas Corporation, Gilbert Estill, Oklahoma Natural Gas Company, and T. S. Whitis, West Texas Gas Company; Domestic Meter Shop Practice, by F. A. Kihneman, Arkansas-Louisiana Gas Company; "Obtaining Performance From District Regulators," by H. F. Roux, Arkansas-Louisiana Gas Company; "Operation of Slide Rule and Gas Rule," by E. E. Ambrosius, the University of Oklahoma; "Back-Pressure Tests of Gas Wells," by E. N. Armstrong, Shamrock Oil & Gas Company; "Gas Accounting—Dry Gas Practices," by J. L. Griffin, Northern Natural Gas Company; "Calculation of Meter Charts," by C. F. Rittman, Jr., El Paso Natural Gas Company; "Determination of Low-Pressure-Line Losses," by C. E. Halloren, The Gas Service Company; "Determination of Specific Gravity," by C. T. Gill, Lone Star Gas Company.

At the class on "Operating and Maintenance Wrinkles for Metermen" conducted by L. F. Carter, Colorado Interstate Gas Company; P. M. Childers, Continental Oil Company, E. S. Doerr, Lone Star Gas Company, C. E. Greiner, Phillips Petroleum Company, and P. H. Miller, Panhandle Eastern Pipe Line Company, honorable mention was given to Charles Fuqua, Consolidated Gas Utilities Corporation; L. F. Carter, Colorado Interstate Gas Company; and J. L. Whipkey, Canadian River Gas Company. Other classes, conducted by representatives of various equipment manufacturers, explained the construction, operation and maintenance of measuring and regulating equipment.

The Thursday luncheon, joint meeting of the executive and general committees and representatives of various equipment manufacturers, was attended by 45. The purpose of this meeting is to obtain constructive suggestions for use in planning future courses.



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Charge stock processed by sulphuric acid catalytic Alkylation produces a 95-plus O.N. blending medium for Aviation Gasoline.

Alkylation increases the possible yield of high octane aviation gasoline and has the following advantages:

- **No excessive pressures or temperatures.**
- **Economical to operate; regenerative process.**
- **Simplicity of design; only standard materials required.**
- **Inexpensive treating agent; negligible loss in processing.**
- **The process greatly increases the lead susceptibility of Aviation Gasoline.**

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165 BROADWAY
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Bureau's May Demand Forecast Up 90,000 Barrels

Domestic demand for petroleum products in May will require the production of 3,799,700 barrels of crude oil daily, 90,400 barrels more than foreseen for April and 2 percent above the actual demand in May, 1940, it was forecast last week by the United States Bureau of Mines.

At the same time, however, the bureau warned that while domestic demand during the first half of 1941 will be much greater than in the same period last year, exports have fallen off and imports are increasing, so that required new domestic production may be as much as 2 percent less than in the first half of 1941.

"During the first six months of 1940," it explained, "the domestic demand for all oils approximated 643,000,000 barrels and exports amounted to 70,000,000, resulting in a total demand for all oils of 713,000,000 barrels. An increase of about 42,000,000 barrels in the stocks of all oils indicated a new supply of 755,000,000 barrels, of which 39,000,000 was imported and 716,000,000 represented new domestic production of crude, natural gasoline and benzol.

"On the basis of existing data and trends, the Bureau of Mines anticipates that during the first six months of 1941 the domestic demand for all oils will be about 55,000,000 barrels greater than last year and that exports may be 25,000,000 less, resulting in a total demand for all oils of about 743,000,000 barrels, or a gain of 30,000,000 barrels (between 4 and 5 percent). Assuming a seasonal increase in total stocks of only 6,000,000 barrels and total probable imports of 48,000,000 barrels (a gain of almost 10,000,000 barrels), the required new production of domestic oils would amount to about 700,000,000 barrels, or about 2 percent less than for the same period last year.

"While these figures represent only a rough approximation of the demand situation, they do indicate the relative trends in the domestic and foreign markets. During the latter half of 1941, any increase in domestic demand will be more directly reflected in required domestic production because last year's production was more closely coordinated with demand in that period and exports had been reduced to almost minimum levels."

The bureau found that daily average crude production during the four weeks March 8 to April 5 was 3,651,000 barrels and runs to stills 3,608,000 barrels, while during the period domestic stocks increased an average of 45,000 barrels a day, indicating a demand of 3,606,000 barrels, virtually the same as runs.

Strong Domestic Market

The most notable change shown during the first quarter of 1941 was unexpectedly strong domestic market for motor fuel, with sales at a level of from 12 to 13 percent above 1940, it was pointed out.

"While these sales undoubtedly have been inflated by buying in advance of a rising market, it seems a fair assumption that the trend of the domestic demand for motor fuel is from 10 to 11 percent above last year," it was commented. "Stocks of finished and unfinished gasoline, as indicated by current figures, approximated 98,000,000 barrels on March 31, 1941. This figure is about 6,000,000 barrels less than the peak of last year and includes several million barrels more of essential aviation gasoline stocks. While some groups in the industry may still consider these stocks excessive, they do not seem to be sufficiently high to be a disturbing factor in view of the strong demand for motor fuel. With the increase in the demand for gasoline more in line with that expected for other products, higher and more normal gasoline yields and normal seasonal stock reductions seem in order.

"The domestic demand for residual fuel oil showed an increase of about 9 percent during the first quarter of 1941 and may show an increase over last year of 15 percent in the second quarter. The total demand for distillate

Bureau of Mines Forecast of Crude Oil Demand for May

State	Forecast May, 1941	Forecast April, 1941
Texas	1,382,200	1,355,300
California	598,100	596,300
Oklahoma	440,000	429,300
Illinois	336,100	336,000
Louisiana	320,300	299,700
Kansas	213,900	200,700
New Mexico	113,900	109,000
Wyoming	90,900	88,700
Arkansas	83,900	75,700
Pennsylvania	49,100	49,000
Michigan	40,000	44,000
Indiana	23,900	23,700
Mississippi	22,900	20,300
Montana	21,300	21,300
Kentucky	17,100	16,700
New York	14,000	14,000
West Virginia	11,100	11,000
Ohio	11,000	10,000
Colorado	5,200	4,300
Nebraska	4,800	4,300
	3,799,700	3,709,300

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We're waiting *your* call to come to work and do our part in the production of petroleum products essential to our national defense! You'll find us *very economical* and *efficient workers* because we use from 25% to 40% *less air* but give you from 30% to 75% *more power* than ordinary tube cleaners of the same size.

We'll give you the *fastest, most thorough* and *most economical* job of tube cleaning you've ever seen—no matter whether the deposit you want removed is exceptionally hard, thick or gummy.

We *know* that we can please *you*, just as we are pleasing scores of refiners throughout the country, and we can be shipped to you *promptly*. Write for the name of our representative nearest to you. He'll be glad to show you what we can do, or send for a copy of the thirty-six page catalog which fully describes us and the complete family of Wilson tube cleaning equipment.

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PIPE AND TUBE CLEANERS EXCLUSIVELY
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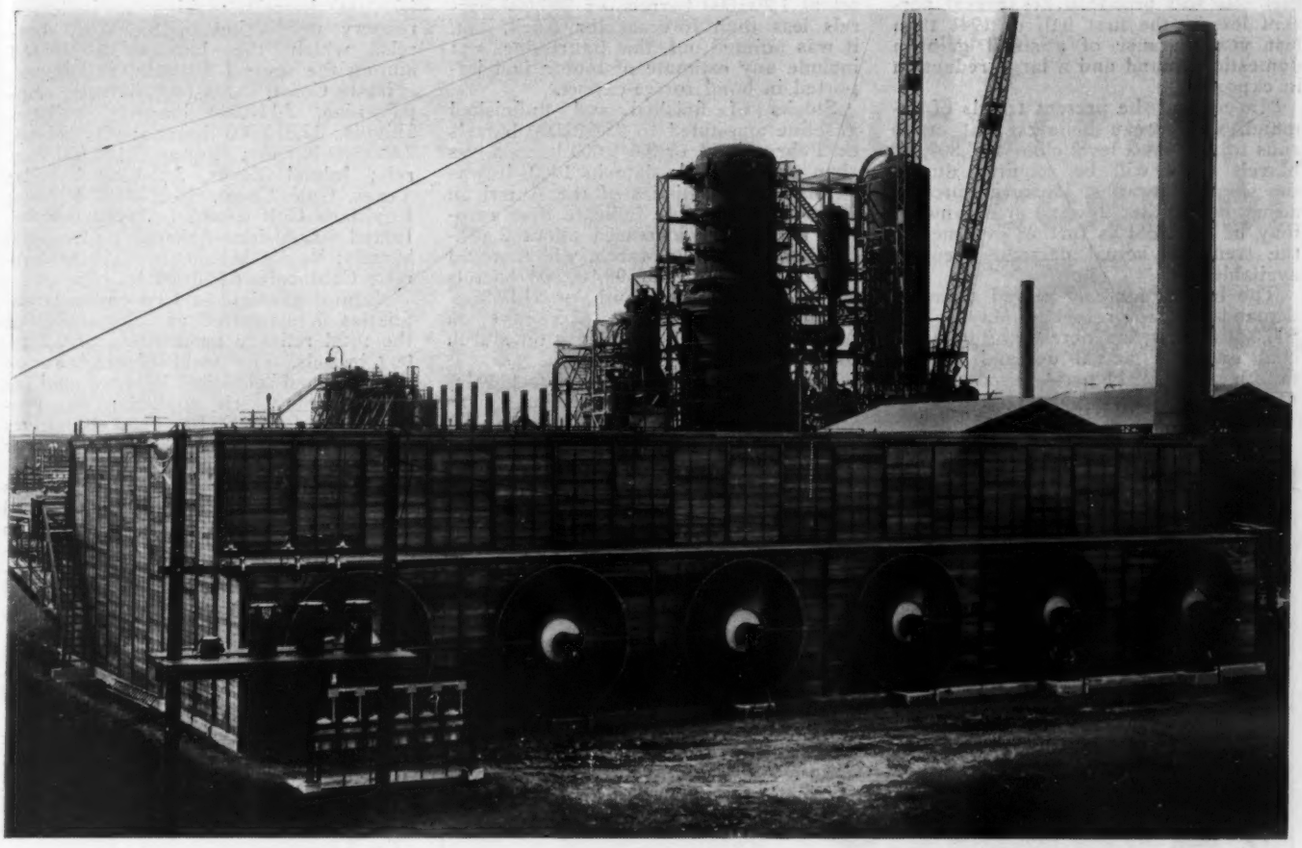

12 cell, low head, forced draft refinery cooling tower, installed close to unit that it serves. Capacity 12,000 gallons per minute; the number of fans in operation depend upon demand for cool water and the prevailing weather.

Mechanical Draft Cooling Towers for Petroleum Refineries

The refining of petroleum involves processes and treatments demanding high capacity in heat dissipation. Mechanical draft cooling—as contrasted with types depending upon atmospheric conditions for effectiveness—provide essential advantages. Low head, forced or induced draft, construction is furnished in designs of proven commercial superiority.

1. Controlled cooling. Mechanical draft maintained by axial flow fans, assures cooled water, regardless of climatic conditions and without increased water loss in high winds.

2. Low pumping head (20 ft.) saves power consumption and reduces cost of pumping equipment.

3. In multi-cell towers, adjustable fan blades and the flexibility in number of cells operated permit highly efficient operation in all seasons of the year.

Foster Wheeler axial flow fans have been developed and are constantly checked for improvement through tests in special wind tunnel. The low annual cost for pumping, and for mechanical draft, are negligible in comparison with the assurance of full plant productivity, and unrestricted processing capacity, even in unfavorable weather.

Foster Wheeler Corporation, 165 Broadway, New York, N. Y.

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fuel oils will probably be several percent less in the first half of 1941 than last year because of a small gain in domestic demand and a large reduction in exports.

"In view of the present trends of demand, the bureau believes that crude runs to stills at a level close to 3,800,000 barrels daily will be required during the summer months. However, prompt adjustment either upward or downward may be essential as further evidence of the trend of actual demand becomes available."

The bureau forecast placed domestic demand for motor fuel in May at 58,500,000 barrels, an increase of 10.5 percent over the actual demand in that month last year. Exports, based on forecasts by the principal exporters, are set at 1,700,000 barrels, or 200,000 barrels less than forecast for April, but, it was pointed out, this figure does not include any estimate of motor fuel imported in bond for re-export.

Stocks of finished and unfinished gasoline amounted to 95,646,000 barrels on February 28, or 3,649,000 barrels less than on the same date in 1940, it was pointed out. Statistics of the American Petroleum Institute indicate that gasoline inventories increased about 2,500,000 barrels during March, which would bring them to about 98,100,000 barrels at the close of the month, or 54.1 days' supply compared with 62.5 days on March 31, 1940, and 54.5 days on March 31, 1939.

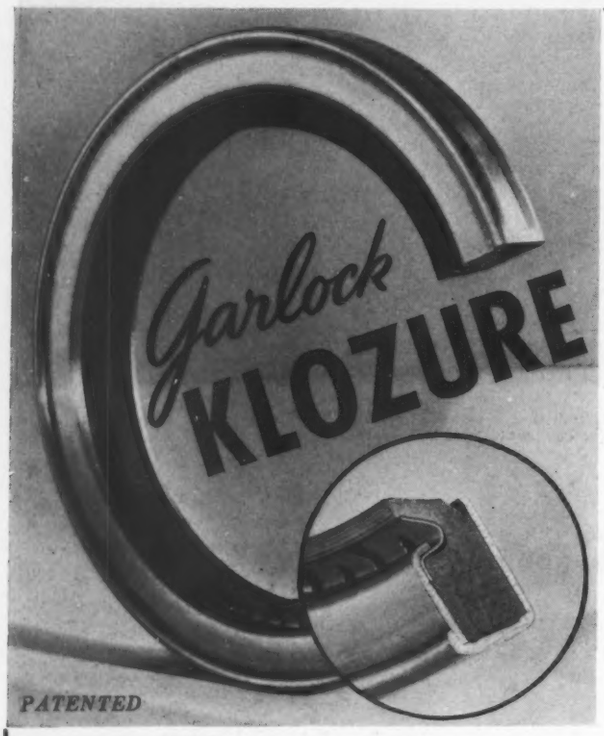
Benzol production and direct sales of natural gasoline are estimated as 1,700,000 barrels, making an indicated refinery production of 55,500,000 barrels, which the bureau distributed among the several districts, as follows:

East Coast, 6,880,000 barrels; Appalachian, 2,110,000 barrels; Indiana-Illinois, 12,310,000 barrels; Oklahoma, 2,690,000 barrels; Kansas, 3,110,000 barrels; Inland Texas, 3,550,000 barrels; Texas Gulf Coast, 14,020,000 barrels; Louisiana Gulf Coast, 1,630,000 barrels; Inland Louisiana-Arkansas, 1,040,000 barrels; Rocky Mountain, 1,510,000 barrels; California, 6,650,000 barrels.

Natural gasoline to be blended at refineries is estimated as 5.8 percent of the total refinery production, or 3,220,000 barrels. The yield of straight-run and cracked gasoline is estimated as 44.5 percent which, applied to the production of 52,280,000 barrels, gives crude runs of 117,490,000 barrels, or 3,790,000 barrels a day.

The estimate for foreign crude runs to stills is 3,900,000 barrels, compared with actual runs of 3,384,000 barrels in May, 1940. Exports are placed at 2,500,000 barrels, compared with actual shipments of 4,886,000 barrels last year, and crude to be used as fuel and losses is placed at 1,700,000 barrels.

The bureau, on the basis of these figures, placed the total demand for domestic crude oil in May at 117,790,000 barrels, or 3,799,700 barrels a day, allocated among the several producing states, as shown in an accompanying table.



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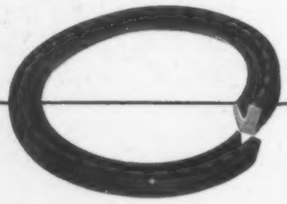

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To meet the need for an Oil Seal that can be installed around the shaft, rather than over the end of the shaft, Garlock has developed the patented SPLIT-KLOZURE. For all shafts of 3" diameter and larger. Write for special catalog.

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Tulsa, Okla.

Houston, Texas

Los Angeles, Calif.

Priestly Medal Goes To Thomas Midgley, Jr.

Thomas Midgley, General Motors Research Division, and discoverer of tetra ethyl lead as an anti-knock ingredient for gasoline, was awarded the Priestly Medal at the meeting of the American Chemical Society in St. Louis, April 7-11. He is chairman of the board of directors of the society.

Question Program for Ark-La-Tex Division

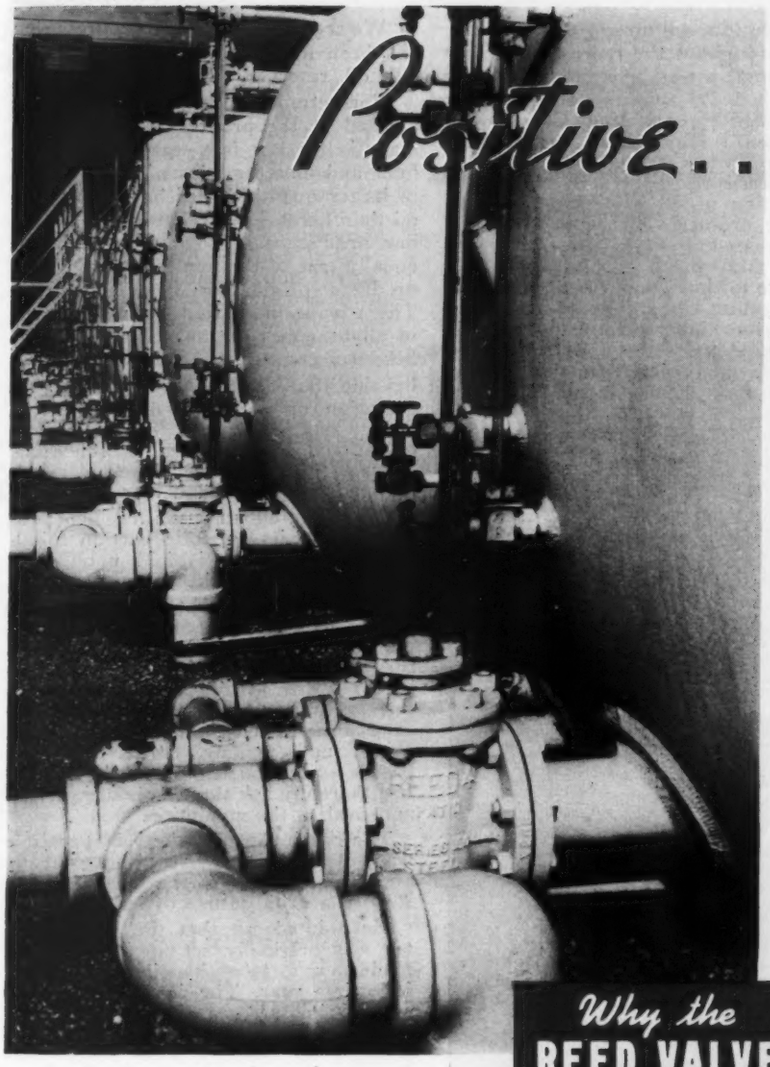
The May meeting of the Ark-La-Tex Division, Western Petroleum Refiners Association, held at Shreveport May 9, was confined to a series of questions which had been submitted to technical men and plant operating personnel.

A. W. Trusty, chief chemist of Arkansas Fuel Oil Company, Shreveport, was in charge of the program.

James D. Redding Joins SAE Staff

James D. Redding, former assistant chief of the Aircraft Airworthiness Section, Civil Aeronautics Administration, has joined the headquarters staff of the Society of Automotive Engineers.

Redding will be staff representative in charge of the society's aeronautical activities, including expanded standardization undertakings in connection with the Office of Production Management assignment to the society of responsibility for standardization work on aircraft engines, propellers, materials and processes, and accessories and equipment; meetings, and other society work in the aeronautical field. He succeeds Carleton E. Stryker, who was released by the society to serve in the Office of Production Management as coordinator of aeronautical standards for national defense.



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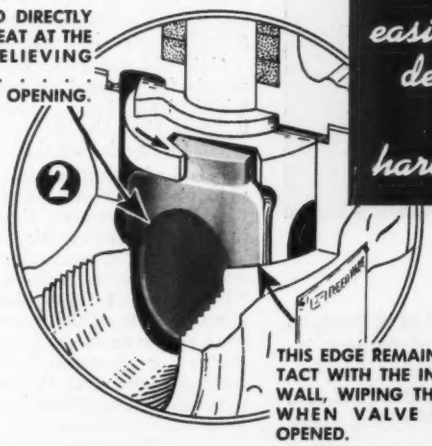

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Cole Committee Finds Need for Federal Oil Control

Indicating that there was no immediate need for Federal control of the petroleum industry but that it was advisable for Congress to keep in close touch with developments, Representative William P. Cole, Jr., chairman of the oil subcommittee of the House Interstate and Foreign Commerce Committee, last week secured continuation of the investigation until January 3, next.

Cole advised the House that his group would recommend legislation to deal with the southeastern pipe line situation next week and that, later in the session, reports would be submitted on other phases of the oil situation. He refused, however, to reveal what form the pipe line legislation would take.

A resolution continuing the subcommittee throughout the remainder of the current session was brought before the house April 29, and its adoption was urged by Representative Charles A. Wolverton, a Republican member of the group, who pointed out that this would afford an opportunity "to study the question of oil production and its attendant problems in the light of the needs created by the present emergency" and make recommendations from time to time should changing conditions require Congressional action.

Wolverton highly commended the oil industry and the states for the manner in which they were attacking their problems, and pointed out that the subcommittee last month made surveys of conditions in Louisiana, Arkansas and Texas.

"We are gratified by the progress that has been made in the conservation of our oil reserves," he told the house.

"Furthermore," he said, "we were amazed at the progress that has been made in the last few years in obtaining finer and better grades of gasoline and in larger quantities per barrel of crude oil than heretofore. What is true of this one product, taken from crude oil, is equally true of the numerous and varied products originating from petroleum. The advancement that has been made in all branches of the oil industry has been so great that it is almost unbelievable. Suffice it to say that our observation of what the oil industry is doing, and is prepared to do in behalf of national defense gives assurance and courage to all who are interested in our national security and defense.

"The oil industry can be depended upon to do its patriotic part in fulfilling whatever task is laid upon it in the days that are ahead.

"The committee that has the responsibility of making recommendations to the Congress for legislation dealing with this great industry believes that it can best perform its duties and fulfill its responsibilities by continuing in existence during the emergency that now exists, and making recommendations based upon conditions as they arise. We therefore ask that the house give its approval to the resolution."

The continuance of the subcommittee was voted by the House without debate, and Cole inserted in the Congressional Record a brief outline of its history.

He pointed out that the subcommittee was originally set up in 1934, and made a report on the oil situation the following year. The investigation was revived in 1939, at the suggestion of President Roosevelt, and that it was planned to make a final report last January, but prior thereto the President asked for an investigation of the national defense aspects of the situation and the subcommittee was given a four-months extension due to expire May 1.

Cole did not refer specifically to proposals for federal control of production which have been advanced, but made it clear that the subcommittee saw no need for such regulation.

"It is pleasing to the committee to be able to report at this time, preliminary to our final report, that the petroleum industry is apparently in shape to meet almost any conceivable demand made upon it in these serious times," he said. "The conduct of certain states toward conservation of this most important natural resource is not what it should be, but we are hopeful before our final report is made that that situation will be materially improved."

Charles B. Kass Joins Ethyl Staff

Charles B. Kass has been appointed coordinator of performance and endurance tests on the road for Ethyl Gasoline Corporation. He will be in charge of endurance and performance tests at Detroit, and will coordinate similar tests made at laboratories at San Bernardino, California, and other points. Kass formerly was with Standard Oil Development Company.

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Monopolistic Charge Hit by Commerce Official

Findings of the Department of Justice monograph on the oil industry, prepared for the Temporary National Economic Committee, that some 20 large operators dominated the whole field of petroleum in this country are "inaccurate, incomplete, and ex parte," members of the House appropriations committee were told by John W. Frey of the Petroleum Conservation Division of the Department of Commerce, during hearings on the department's appropriation bill for the fiscal year 1942.

Refusing to take advantage of permission granted by the committee to have his remarks "off the record," Frey insisted that they were "on the record" and declared that "no group of companies by collusion dominate the entire price structure of the United States."

"Price structures," he said, "are the result of the interplay of all the forces."

Accompanied by Frey, associate director for marketing and refining, and Jack W. Steele, chairman of Federal Tender Board No. 1, George W. Holland, director of the Petroleum Conservation Division, outlined the activities under the Connally Act. While the division has an appropriation of $255,000, it does not expect to expend more than $240,000, and the latter amount was provided in the bill for 1942.

During his testimony, Holland was asked by Representative Harry R. Sheppard how much money was spent "for the purpose of confiscating the tide lands of the great state of California."

"Not a nickel of it," Holland declared.

Bottlenecks in Oil Industry Unlikely, Chamber Is Told

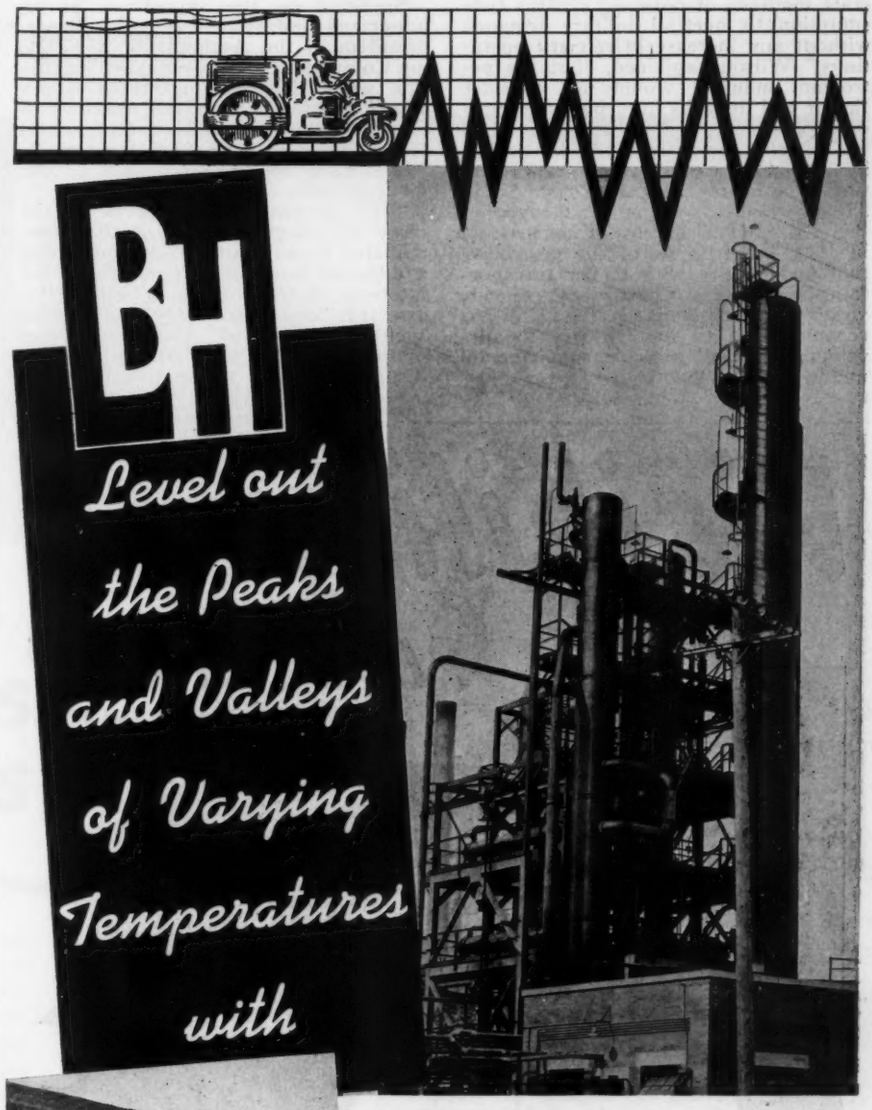
"No industy of comparable importance to defense has so few even potential bottlenecks as the petroleum industry," members of the United States Chamber of Commerce were told by Dr. Robert E. Wilson, oil consultant of the Office of Production Management, April 30 at the oil industry "round table" which featured the chamber's annual meeting.

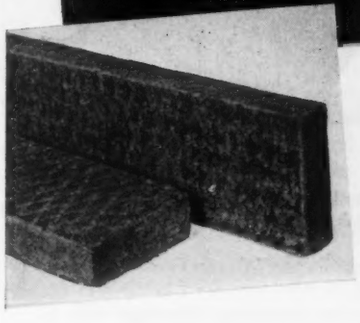
Recent state-by-state estimates indicate that, without any excessive drilling programs, production could be increased by 30 percent and maintained at that level for at least two years without any major new discoveries," he declared in reviewing the position of the industry.

"Of course," he added, "the industry must not relax its normal activity toward making new discoveries, but it should avoid unnecessary drilling and unsound well-spacing programs which use up capital, labor and steel to no useful purpose. New wells and fields must be discovered and connected up and new pipe lines built as old fields decline. I am sure that if our producers are given freedom of opportunity, subject to the limitations of sound proration regulations, they will see that every possible demand is met for many years to come."

The immediate expansion of output to meet sharp increases of demand is not quite as great in refining as in production, he told the meeting, but our civilian demand is so large that it still dwarfs every possible military demand, although a few special products require special attention.

"It would be possible, by rather mod-





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erate methods of reducing civilian consumption, to meet all military demands without any increase in refinery operations," Wilson explained, "but the petroleum industry would not consider that it had done its duty by its country or its customers if this had to happen."

The most serious possible bottleneck in the industry is in tanker transportation facilities on the East Coast. About 25 large tankers are due for completion this year and 50 are to be constructed in 1942, but in view of the possibility that interference with tanker transportation on the East Coast might coincide with emergency demands, the OPM has recommended to the industry the development of all possible supplemental methods of transportation.

Speaking on the importance of an integrated industry, Paul G. Blazer, president of the Ashland Oil & Refining Company, called attention to legislation which has been proposed which would divorce the various activities of the oil industry which, if enacted, would lose to the public much of the savings which have been accomplished by the oil companies.

"The present effort to break up the large oil companies into smaller non-affiliated corporations, each performing a different function, is contrary to the interests of the consuming public," he asserted, "and conceivably might cause such disruption of long established methods of operation as to interfere disastrously with our national defense program. Aside from all other considerations, such a novel experiment, involving drastic changes in management in a vital defense industry, constitutes an unnecessary risk."

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Phillips Acquires Plant; Expansion Planned

The Balco Gasoline Corporation's natural gasoline plant in the Dill pool of Okfuskee and Seminole counties, Oklahoma, has been sold to Phillips Petroleum Company for about $150,000. Plant has a capacity of 5,000,000 feet of gas, with production of 10,000 gallons of natural gasoline per day. With development of greater natural gas reserves resulting from north extension of Dill pool, the plant's capacity is expected to be doubled, with construction to begin shortly.

Ohio Oil Adds Poly Unit at Robinson, Illinois

The Ohio Oil Company has signed a license agreement with Universal Oil Products Company to install a U.O.P. non-selective catalytic polymerization unit in its refinery at Robinson, Illinois.

The unit was designed by Universal Oil Products Company engineers and is being built by The Ohio Oil Company. The charge for the unit will be the higher olefins produced in cracking by four Holmes-Manley units and one Kellogg unit. New stabilization equipment is being installed to stabilize the cracked gasoline and prepare the charge for the poly unit.

R. E. Luton is superintendent of refineries for the company and R. W. S. Musgrave is chief engineer.

Plan Four Cycling Projects In Southwest Texas Fields

Expansion of Southwest Texas cycling-plant construction is anticipated with two more plants in prospect. Two more announced projects bring the total immediately contemplated to four.

A series of tests are determining the reserve qualities of the Parr ranch holdings of Benedum & Trees Oil Company east of Benavides in Duval County. Several distillate sands through the Jackson and Cockfield zones are productive in the area east of the North Sweden field and these pays will be produced through this method.

W. R. Davis, Inc., has started the first well on the McAllen structure in Hidalgo County. Several tests are contemplated, following which a cycling plant is proposed. The sands range down to 7500 feet.

Plans already have been announced by Champlin & Bass, Inc., for a plant and development of the condensate reserves of the Sejita field, Duval County, while H. B. Zachry Company is to immediately build a plant in the Francitas area of Jackson County.

Peruvian Refinery Will Have 10,000-Barrel Capacity

A Peruvian government refinery with daily capacity of 10,000 barrels is near completion at Villar. Oil for the plant will be taken from government wells, although royalty oil produced by Lobitos Petroleum Company will also be run.

Peruvian oil production in 1940 was

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*The reference here is to stresses caused by line movements due to expansion, rather than those caused by internal pressure. Mathematical analysis shows that stresses are maximum in the curved section of the fitting and that such stresses far exceed those existing in the straight section even at points quite close to the point of tangency.

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5. **Wall thickness never less than specification minimum**—assures full strength and long life.
6. **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
7. **The most complete line of Welding Fittings and Forged Steel Flanges in the World**—insures complete service and undivided responsibility.

†Since the marking is pressed into the metal before forming, and since the manufacture of the fittings is carried out at a forging temperature, each in effect receives a heat treatment after the operation. The indentations have no sharp corners or edges and the marking has no effect on the strength of the fitting.

approximately 13,420,000 barrels, compared to 13,510,000 barrels produced in 1939. Chief war losses of the Peruvian industry have been in the markets of France, United Kingdom and Germany, but exports to Chile, Canal Zone and Japan rose last year. Japan's takings were largely crude rather than refined oils.

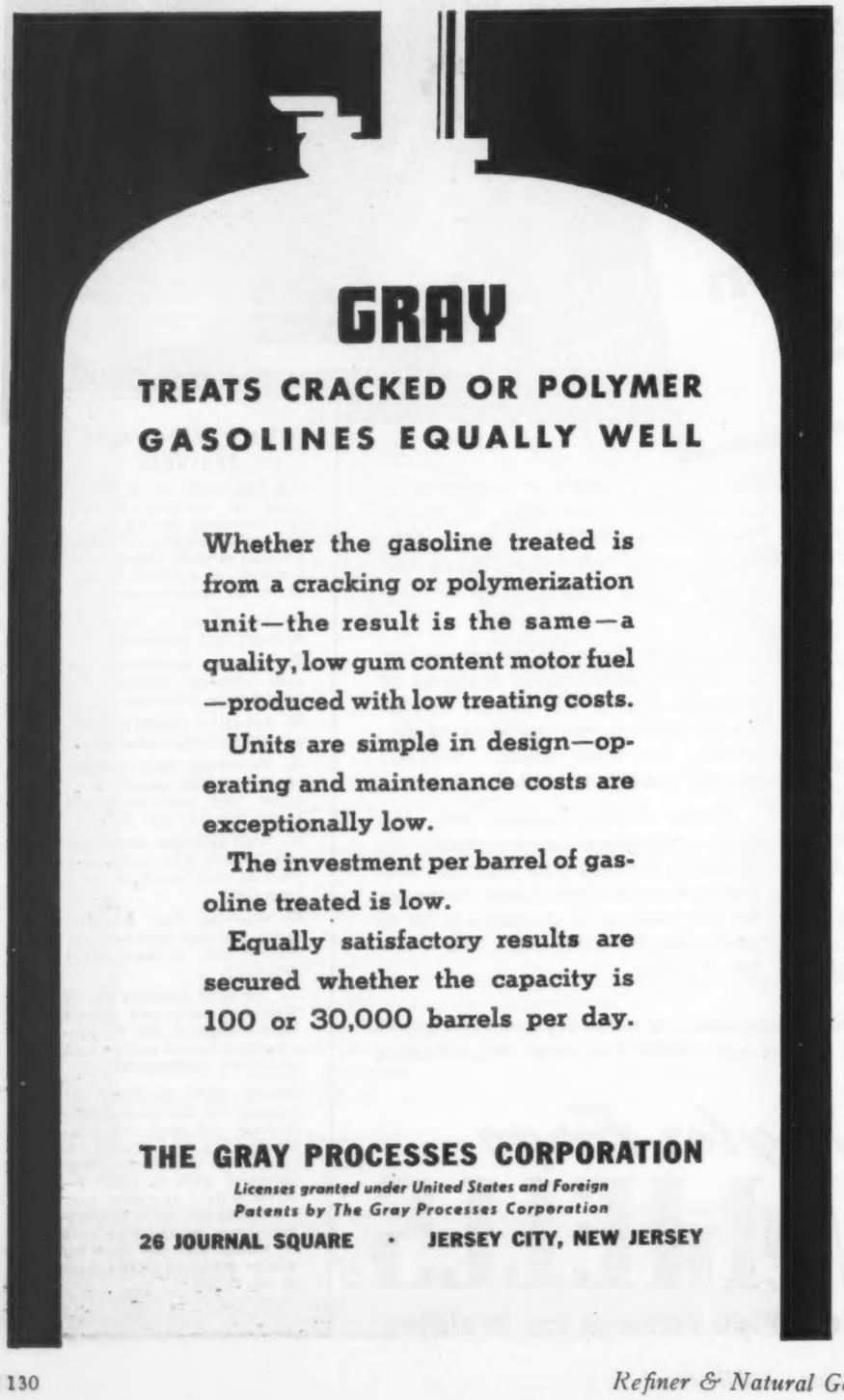
In 1940 as a result of successful exploration work by Blue Goose Oil Company on the Agua Caliente concession, upper Ucayali valley, the government issued a resolution reserving the petroleum rights in the zone bounded by parallels 6 and 8 of south latitude, the Ucayali river on the west and the Brazialian line on the east. Government explorations at Cope met with some success.

License Required for Export of Processes

A further tightening of control of exports of oil field and refining equipment from the United States is seen in recently announced Export Control Schedule A. Licenses are required to export Any model, photograph, photographic negative, document or other article or material, containing a plan, specification, or descriptive or technical information of any kind (other than that appearing generally in a form available to the public) which can be used or adapted for use in connection with any process, synthesis or operation in the production, manufacture or reconstruction of any of the articles or materials the exportation of which is prohibited or curtailed in accordance with the provisions of Section 6 of the Act of Congress approved July 2, 1940, or of any basic or intermediary constituent of any such articles or materials."

Technical data pertaining to aviation fuel and lubricating oil had previously been subjected to license requirements. The latest action extends export control to technical data relating to articles, materials and their derivatives that are themselves subject to license.

The license requirement does not apply to "Information which has been made available generally to the public as issued patents, copyrighted articles, materials which have been available to the public through technical or other periodicals."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Diller Heads Petroleum Electrical Association

C. O. Diller, Lone Star Gas Company, Dallas, was elected president of the Petroleum Industry Electrical Association when the organization held its annual convention in Tulsa April 23 in conjunction with the Petroleum Electric Supply Association. He succeeds O. V. Summers, Houston. More than 300 attended the meeting.

Other officers named were L. G. Wainman, El Paso Natural Gas Company, vice president, and J. F. Collerain, Houston, re-elected secretary. H. C. Gear, Lone Star Gas Company, Dallas, was elected chairman of the Cathodic Section, succeeding L. F. Scherer, Texas Pipe Line Company, Houston; J. F. McElhatton, Panhandle Eastern Pipe Line Company, Kansas City, was named vice chairman, and G. R. Olson, United Gas Pipe Line Company, Shreveport, was renamed secretary.

Shreveport was selected as the 1942 convention city, with the meeting to be held April 22-24.

Principal address was given at the banquet session by A. A. Nicholson, director of The Texas Company, New York, who spoke on "The New Industrial Frontier."

Lincoln Award To Be Awarded This Fall

As part of the program of the annual meeting of the American Welding Society in Philadelphia this fall, the Lincoln Gold Medal will be presented for the fifth time.

It is presented annually to the author, or authors, of the paper which is judged the greatest original contribution to the advancement and use of welding and which is published in "The Welding Journal" during the year ending with the annual meeting. The medal was donated to the society by J. F. Lincoln, president of Lincoln Electric Company, Cleveland. The purpose is to encourage the presentation, before the American Welding Society, of papers which are effective in promoting the use of welding.

Last year's award went to H. J. French and T. N. Armstrong, Jr., International Nickel Company, New York. Their paper was entitled "Weld Hardening of Carbon and of Alloy Steel." It was published in the October, 1939, issue of "The Welding Journal," and presented at the society's annual meeting in Chicago during October, 1939.

SCIENCE AND TECHNOLOGY

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The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included.

Photostat copies of original articles will be supplied at cost by the Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Physical and Chemical Data

A New Method for Determining the Specific Heats of Gases and Vapors, K. BENNEWITZ AND O. SCHULZE, *Z. Physik. Chem.* **A186** (1940) pp. 299-313.

The stream of gas is passed through a small glass tube connecting two metal blocks held at different temperatures. The tube is imbedded in insulating material and the flow of gas produces a change in the temperature distribution in the insulator. This change is compensated by electric heating. The method is adiabatic and the apparatus can be operated continuously at approximately atmospheric pressure. A new method for regulating and determining the velocity of the gas stream is described. The value of C_p for air changes from 6.960 cal/mole at 52.2° C. to 6.972 at 77.5°. The values for 10 intermediate temperatures are given. The thermal conductivity of kieselguhr is 2.385×10^{-4} cal. $cm.^{-1}$ $deg.^{-1}$ $sec.^{-1}$ for a pressed sample and 2.078×10^{-4} for a tamped sample.

Line Coordinate Chart for Vapor Pressures of Organic Solvents, D. S. DAVIS, *Ind. & Eng. Chem.* **33** (1941) p. 401.

From a study of data presented by Gardner covering the vapor pressure of eight organic solvents the author shows that the relationship between p, the vapor pressure in mm. of mercury, and t, the centrigrade temperature, is given by the equation.

$$\log p = \frac{A}{t + 253} + B$$

where A and B are constants specific to the compound. A line chart is presented that gives the vapor-pressure data in compact and convenient form. Among the hydrocarbons included are diisoamylene, diisobutylene, isodecane, and isooctane.

The Vibrational Energy Levels and Specific Heat of Ethylene, E. J. BURCIK, E. H. EYSTER AND D. M. YOST, *J. Chem. Phys.* **9** (1941) pp. 118-19.

Conn and Sutherland have revised the position of the "Torsional" level of C_2H_4 to 700 $cm.^{-1}$. Bonner's assignment is more satisfactory. The heat capacity of C_2H_4 gas was determined at 271, 300 and 321° K. The results agree with those of Heuse and Eucken and Parts, and with a heat capacity calculated with the "torsional" level at 828.5 $cm.^{-1}$. In the range 165-465° K. these theoretical heat capacities are represented in calculated/mole-degree (±0.02) by the empirical expression $C_p^\circ = 9.638 - 3.109 \times 10^{-2}\,T + 1.551 \times 10^{-4}\,T^2 - 1.426 \times 10^{-7}\,T^3$.

Energy of Aliphatic Carbon Links, E. C. BAUGHAN AND M. POLANYI, *Nature* 146 (1940) p. 685.

Q can be derived from heats of formation $RH + XY = RX + YH + Q$. For a series of different radicals R the heats vary as the substitution heats in corresponding reactions of the type $RH + X = RX + H + Q'$. Values of Q′ are tabulated for X = (1) Me, (2) Br, (3) OH, and (4) a free valence in the β-position. For MeH, EtH, n- and sec-PrH, and tert-BuH. The Q′ values are combined with measured bond energies of C-I, to give the bond energies of C-I, C-Br, C-H, C-Me, C-OH, and the second valence in an α-β double bond, each attached to each of the same five aliphatic radicals. The results are discussed in some detail.

Thermal Conductivity of Liquids, O. K. BATES, G. HAZZARD AND G. PALMER, *Ind. & Eng. Chem.* **33** (1941) p. 375.

The paper presents the results of the experimental determinations of the thermal conductivity and temperature coefficients of thermal conductivity of twelve chlorinated hydrocarbons available commercially. The chlorinated hydrocarbons studied were methylene chloride, chloroform, carbon tetrachloride, dichloroethylene "Di-48," dichloroethylene "Di-60," trichloroethylene, tetrachloroethylene, ethylene dichloride, β-trichloroethane, tetrachloroethane, pentachloroethane, and propylene dichloride. The method used in the work has been previously described by the authors. Reference is made to this description. The data are presented in some detail in tabular form.

The Effect of Potassium Oleate upon the Solubility of Hydrocarbon Vapors in Water, J. W. MCBAIN AND J. J. O'CONNOR, *Jour. Am. Chem. Soc.* **63** (1941) pp. 875-7.

The solubility of isobutane, butadiene, and propylene in water, and in solutions of potassium oleate were studied. At an equilibrium pressure of 400 mm. of propylene the solubility was increased from 9.8 cc./100 cc. in water to 39 cc./100 cc. in a solution containing 15% potassium oleate. Data are given showing the increase in solubility of isobutane and butane. These show increased solubility in the presence of potassium oleate acting as solubilizers.

Spontaneous Ignition of Hydrocarbons, C. W. SORTMAN, H. A. BEATTY AND S. D. HERON, *Ind. & Eng. Chem.* **33** (1941) pp. 357-60.

The so-called spontaneous-ignition temperature of a combustible liquid is not a definite property but varies according to the method of test. The application of any one suitable test method to different combustibles will give comparative results that have considerable significance. For evaluating the fire hazard arising from the contact of liquids or vapors with a hot surface, the Moore oil-drop or crucible method of test is the simplest and will correlate with the actual behavior found in practice on a larger scale. Spontaneous ignition temperatures in air, and the corresponding time lags, were determined for

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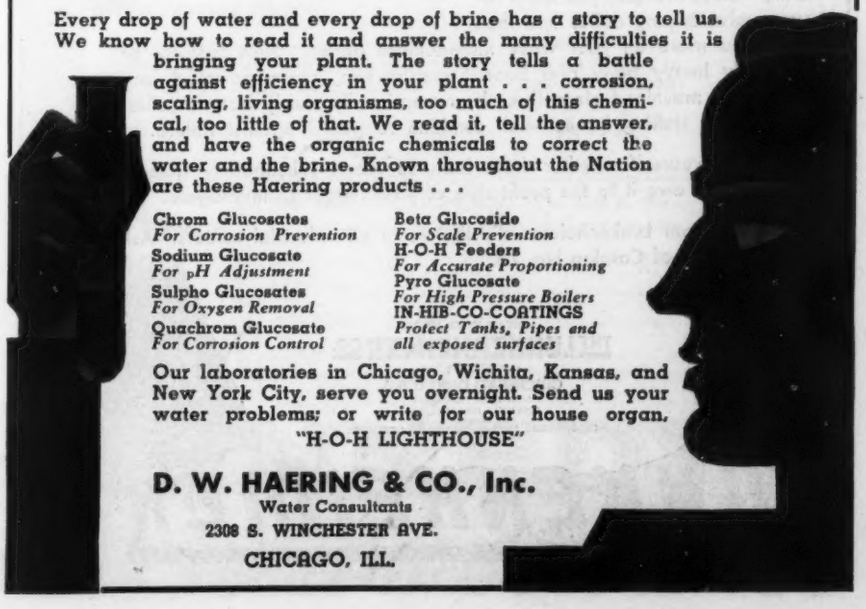

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a variety of hydrocarbons at atmospheric pressure by the Moore method, using a steel crucible and different air flow rates and liquid drop sizes. Under some conditions of air liquid feed the readily ignited hydrocarbons, such as cetane and heptane, show two separate temperature zones of non ignition above the minimum ignition temperature, a behavior heretofore unobserved; under other conditions one or both of these zones may be eliminated. The conditions of air and liquid feed have a marked effect on the ignition time lag, especially at low temperatures. Addition of tetraethyllead completely inhibits ignition up to about 850-1000° F. The apparatus used in testing is illustrated and described in some detail, and the results are given in tabular and in graphical form.

Chemical Compositions and Reactions

The Nitrogen Compounds in Petroleum Distillates. XX. Isolation of 2-Methyl-8-Ethylquinoline from California Petroleum and Proof of Structure Through Degradation and Synthesis, R. A. GLENN AND J. R. BAILEY, *Jour. Am. Chem. Soc.* **63** (1941) pp. 639-41.

The authors report the isolation of two new $C_{12}H_{13}N$ bases from the Edeleanu kerosene extract of California petroleum. The structure of one of these bases has been established as 2-methyl-8-ethylquinoline through degradation and synthesis. The formation of 8-quinolyl methyl ketones in potassium dichromate oxidation of 2-methyl-8-ethyl- and 8-ethylquinoline is described.

The Nitrogen Compounds in Petroleum Distillates. XIX. The Isolation from California Petroleum and Synthesis of 2,3,8-Trimethyl-4-Ethylquinoline. R. A. GLENN AND J. R. BAILEY, *Jour. Am. Chem. Soc.* **63** (1941) pp. 637-8.

The paper reports the isolation and synthesis of 2,3,8-trimethyl-4-ethylquinoline present in the Edeleanu kerosene extract of California petroleum. This compound is the first quinoline homolog obtained from this material with an alkyl group on the Py-nucleus higher than methyl. The base was degraded to the previously unknown 2,3-dimethyl-4-ethylquinoline, the structure of which was confirmed by synthesis.

A Contribution to Chromic Acid Oxidation of Quinoline Homologs and Oxidation of Bz-Ethylquinolines to Quinolyl Methyl Ketones, R. A. GLENN AND J. R. BAILEY, *Jour. Am. Chem. Soc.* **63** (1941) pp. 641-3.

In connection with the study of the hydrogen bases of California petroleums experimental proof is presented of (1) an increased yield of carboxylic acids by employing stepwise chromic acid oxidation of 8-alkylquinolines and (2) an increase in the velocity of reaction, where chromic acid anhydride is employed, by the addition of potassium acid sulfate. The direct conversion of Bz-ethylquinolines to corresponding Bz-quinolyl methyl keytones through oxidation with chromic acid anhydride or dichromate is reported.

Septration and Composition of a Lubricating Oil Distillate, M. R. FENSKE AND R. E. HERSH, *Ind. & Eng. Chem.* **33** (1941) pp. 331-8.

A Pennsylvania viscous neutral oil was studied. The pour point was 20° F., color 3½ A.S.T.M., gravity 30.3° A.P.I., viscosity 176 at 100° F., 44.7 at 210° F. The systematic separation of the distillate by selective solvent extration and fractional distillation into portions comprising 0.6 to 1.4 weight per cent of the original oil allowed the construction of three-dimensional diagrams incorporating yield, viscosity index, and molecular weight or viscosity. Such diagrams permit an estimation of the distribution of oil fractions with respect to molecular size and molecular type. Used in connection with graphs of boiling-point and aniline-point isotherms superimposed on the composition diagram, methods for the segregation of any portion of the oil are suggested. Comparison of the physical properties of the fractions with those of synthetic hydrocarbons indicates that the fractions, though far from being separated into pure compounds, are segregated into groups ranging from monocyclic naphthenes (C_nH_{2n}) to polycyclic aromatics (C_nH_{2n-18}). The data are presented in an interesting manner in graphical form.

Catalytic Polymerization of Ethylene Under Ordinary Pressure. IX. Polymerization Activity of Nickel Catalyst, Y. KONAKA, *J. Soc. Chem. Ind.* Japan **43**, Suppl. Binding (1940) p. 300.

The effect of nickel catalysts on the forma-

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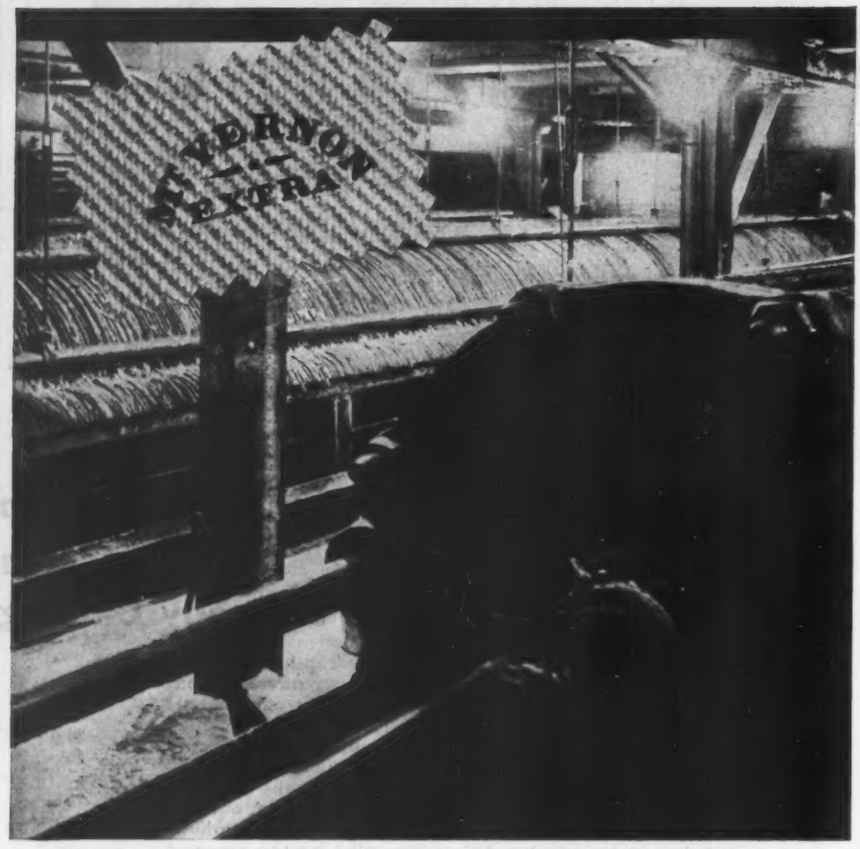

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tion of liquid polymers from ethylene was studied. Both ignited and precipitated nickel catalysts without a supporter showed distinct polymerizing effect, but the action of a nickel catalyst supported on kieselguhr was still more pronounced, the polymerization of C_2H_4 taking place with a fairly good yield at 250° C. In the case of precipitated catalysts, and with respect to polymerization activities, K_2CO_3 was the best precipitant, as compared with Na_2CO_3, NaOH and NH_4OH. The effect of various metal oxides as promoters of oil formation was studied. No significant effects were observed when the oxides of chromium, molybdenum and tungsten were used. U_3O_8, however, had a remarkable influence, ThO_2 showed a good promoting effect, similar to that U_3O_8. Nickel catalysts have a higher activity and longer life for polymerization than cobalt and iron catalysts. It also has an optimum polymerization temperature at about 240-260° C., which is 20-50% lower than that of cobalt and iron. The best catalysts were found to be Ni-ThO_2-U_3O_8-AL_2O_3-kieselguhr in the proportion 10:1.5:1.0:-0.3:15 respectively. This catalyst produced 3.9 cc. of the polymer oil from 14.2 liters of C_2H_4 at 240° C.

Catalytic Polymerization of Ethylene Under Ordinary Pressure. X. General Properties and Chemical Composition of Polymer Oil, Y. KONAKA, *J. Soc. Chem. Ind.,* Japan **43** Suppl. Binding 330-1 (1940).

The properties and chemical composition of the reaction products obtained from C_2H_4 by the action of catalysts were studied. No characteristic differences as regards density, refractive index and unsaturation were observed for the different catalysts. However, the polymer oil showed the highest saturation with a nickel catalyst, the degree of saturation decreasing in the order: Ni, Co, Fe. Both the crude oil and the refined oil, when freed from unsaturated and aromatic hydrocarbons, showed almost identical distillation curves. The main part of the oil was composed of olefin hydrocarbons. No diolefins products were composed mainly of olefin with were detected. The gaseous polymerization a slight amount of saturated hydrocarbons.

The Polymerization of Olefins. II. The Copolymerization of s-Butyl and t-Butyl Alcohols by Sulfuric Acid, F. C. WHITMORE, K. C. LAUGHLIN, J. F. MATUSZESKI AND J. D. SURMATIS, *Jour. Am. Chem. Soc.* **63** (1941) pp. 756-7.

The copolymerization of s-butyl and t-butyl alcohols was studied in connection with the mechanism of the polymerization of the olefins by acid catalysts. It was thought that the symmetrical nature of the chief olefin formed by the dehydration of s-butyl alcohol, i.e., 2-butene, should serve to limit the isomers in the polymer. The copolymerization of s-butyl and t-butyl alcohols with 75% sulfuric acid was found to yield 25% diisobutylenes, 40% 3,4,4-trimethyl-2-pentene, and 35% 2,3,4-trimethyl-2-pentene. The last compound is formed by an unusual type of rearrangement involving a 1,3-shift of a methyl group.

The Preparation of 2,2- and 3,3-Dimethylpentane, H. SOROOS AND H. B. WILLIS, *Jour. Am. Chem. Soc.* **63** (1941) p. 881.

On account of a previous statement in the literature that 2,2- and 3,3-dimethyl pentane could not be made by the condensation of tertiary alkyl halides with Grignard reagents, the authors studied these reactions. They concluded that the process is entirely workable, and secured yields of 27% of 2,2-dimethylpentane from t-butyl chloride with n-propyl magnesium chloride, and 43% of 3,3-dimethylpentane from t-amyl chloride with ethyl magnesium chloride. The hydrocarbon synthesized was purified and the physical properties are given as determined.

Chlorination of Olefins in Reactive Solvents with t-Butyl Hypochlorite, C. F. IRWIN AND G. F. HENNION, *Jour. Am. Chem. Soc.* **63** (1941) pp. 858-60.

t-Butyl hypochlorite has been found to be an effective reagent for the preparation of chlorohydrin ethers and esters by reaction with olefins and alcohols, phenol or acetic acid. Twenty products prepared in this manner are described. The reactions appear to be acid-catalyzed. Small amounts of p-toluenesulfonic acid are effective in improving the processes, both in reaction rate and yield.

Manufacture: Processes and Plant

Distillation Equipment in the Oil-Refining Industry, J. W. PACKIE, *Trans. of Am. Inst. Chem. Engrs.* **37** (1941) pp. 51-78.

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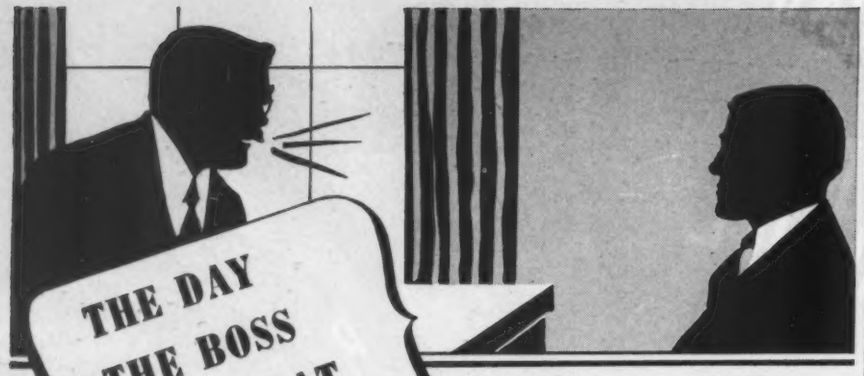

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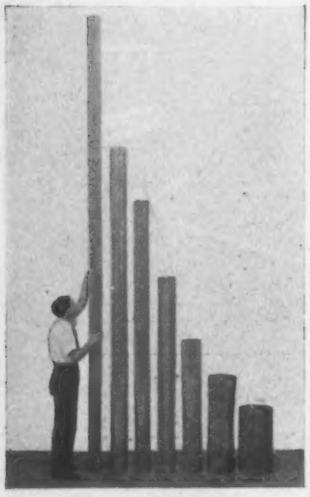

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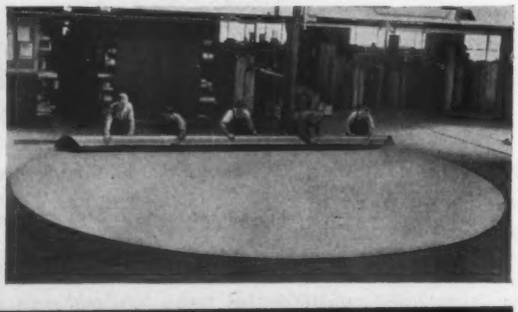

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technology is discussed. Distillation is used in many refinery processes including atmospheric, vacuum and two-stage atmospheric-vacuum distillation of crude oil, atmospheric rerunning of naphthas and refined oils, stabilization of cracked naphtha and absorption naphtha, debutanization, depropanization, in absorption plants, in cracking, in solvent treating and solvent dewaxing, and in polymerization, alkylation and similar plants. Crude oil distillation units are described in some detail. A flow sheet of the typical distillation unit is given, together with distillation curves of the feed oil and the products made. Methods of calculating the percentage of feed stocks vaporized in the flash zone are given. Stripping of bottoms products and sidestream products is discussed, and methods for calculating the amount removed by stripping, and the temperatures of the products are considered. A typical example of the calculation of the top tower temperature is given. Procedures for calculating the number of plates and the reflux ratio required for a given degree of fractionation as obtained from the products made are included. A method of calculating allowable vapor velocity in the column is illustrated by a typical example. The article concludes with a summary showing the calculated and actual test conditions for a typical unit.

Rate of Cracking of Paraffin Wax, L. B. BRAGG, *Ind. & Eng. Chem.* **33** (1941) pp. 376-80.

The purpose of the work reported was to determine the value of the cracking reaction rate constant for the paraffin hydrocarbons higher than butane, and comparable in molecular weight to the raw materials used in commercial cracking. Paraffin wax was selected. Petroleum fractions contain such a wide variety of compounds, both with respect to size and structure, that their use would have been unsatisfactory. Also, the use of paraffin wax permitted accurate determination of the amount of undecomposed material. Commercial paraffin wax of 122° F. melting point was cracked in a small flow apparatus at temperatures between 788° and 900° F. and pressures of 490 to 1870 pounds per square inch. The reaction-rate constants were corrected to give the initial cracking rate. They can be represented by the Arrhenius equation, $\ln k = (-64{,}386)/RT + 16.713$. Pressure does not influence the rate of reaction, and therefore the reaction can be assumed to be unimolecular. The results of the work are presented in graphical form.

The Design of High-Pressure Plant and the Properties of Fluids at High Pressures, D. M. NEWITT, pp. viii + 491. Oxford University Press. 1940. Price 35s.

During the last twenty years the successful application of high pressures in industry has resulted in extended studies of the properties of matter and of the kinetics of reactions at high pressures. In this book Professor Newitt confines himself to describing the effects of pressure on physical processes occurring in fluid systems. The book is divided into two parts. Part I is devoted to the design of high-pressure equipment, and commences with a chapter on materials of construction, which is followed by a chapter on pressure vessels. Chapter III is concerned with the "Calculation of Stresses and Strains in Pressure Vessels" and contains an informative discussion on "The Design of High-Pressure Equipment." The first part of the book concludes with a chapter on "The Measurement of High Pressures." The thirteen chapters included in Part II of the book deal almost entirely with the physical properties of fluids at high pressures. Following a short introduction dealing with the kinetic theory, the P.V.T. relationships of gases and the equation of state problem are discussed. Recent work on compressibility and the volumetric behavior of the more important gases and some of their binary mixtures, as well as one ternary mixture are included. The liquefaction of gases, and the use of enthalpy-enthropy and temperature-entropy diagrams in the design of compressors and circulating pumps are discussed. The effect of pressure on viscosity, and the dielectric strength and refractivity of gases is considered in two chapters; another describes the effect of pressure on viscosity and refractivity of liquids. Tables of data on the thermodynamic properties of hydrogen, nitrogen, carbon monoxide, carbon dioxide, and methane are included in Appendix I. Appendix II gives data on the Joule-Thompson coefficient for nitrogen, air, helium, and argon. A description of experimental equipment and methods included in the book will be found particularly helpful to investigators engaged in high pressure research work.

Orifice Nomograph, D. S. DAVIS, *Ind. & Eng. Chem.* **33** (1941) p. 420.

Frequently it is desired to calculate the rate of flow of water through standard orifices, nozzles, and spray pipes. The discharge equation $Q = CAV$ can be written $Q = CA\sqrt{2gh} = 8.02CA\sqrt{h}$. To avoid small numerical values the rate of flow in gallons per minute is more convenient and is given by $R = 19.64Cd^2\sqrt{h}$ in which d = diameter of the orifice in inches and h is the head of

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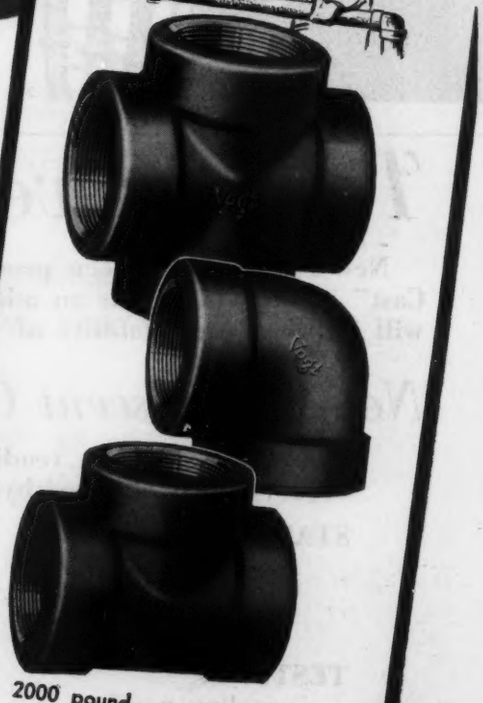

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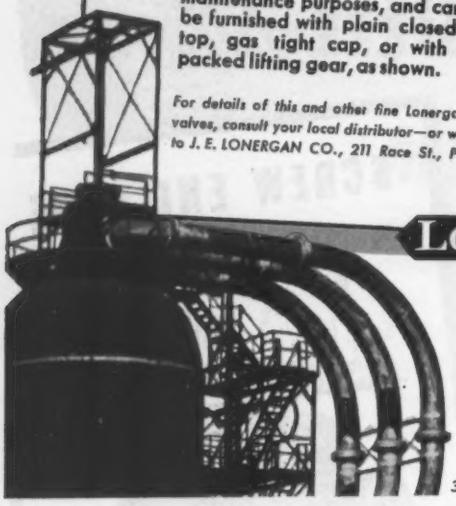

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water in feet. An alignment chart is presented that solves the expression readily. It includes several gage points corresponding to values of C for four commonly used types of orifice: the short or free-running Borda mouthpiece, square and beveled orifices in thin plates, and an orifice in a plate of thickness equal to 2 to 3 orifice diameters.

Products: Properties and Utilization

Fuel Rating: Its Relation to Engine Performance, A. M. ROTHROCK, *S. A. E. Journal* **48** (1941) pp. 51-65T.

With respect to aircraft engines and fuels, the author considers that the occurrence of knock depends on the interrelation of the density and temperature of the end-gas. For any particular fuel, this relation can be expressed as a single function including the inlet air pressure and temperature and the compression ratio, together with constants characteristic of the fuel and the engine. Experimental data confirmative of the foregoing are given for 5 fuels. The calculated effects of the variables in the engine conditions are plotted. Since, for fuels of various types the relative knock-ratings may vary greatly with engine conditions, it is useless to expect a single knock-rating method to be entirely adequate, and separate ratings should be made under suitable conditions—e.g., at take-off and at cruising conditions. Preignition is not directly related to knock, and is largely independent of engine operating conditions; at present, there is no satisfactory test for the preignition tendency of fuels. Engine data for preignition by the hot-wire method show equal and constant temperatures for isooctane, benzene and toluene in theoretical and rich mixtures. Different methods of fuel ratings are considered, and the difficulty in attempting to express both knock and preignition characteristics by a single method is emphasized.

Fuel and Oil for Motor Transport, T. A. BOYD, *Ind. & Eng. Chem.* **33** (1941) pp. 324-30.

Chemistry offers the chief assurance that the first need of the future for motor transport, i.e., a plentiful supply of oil and liquid fuel, will be met. This assurance arises through all the chemist and chemical engineer are doing to help find petroleum, to get the maximum amount of oil from the sand, to refine each barrel of petroleum to best advantage, to utilize fuel and oil efficiently, and to make coal, oil shale, and vegetation available as reserves for the more distant future. In gasoline, both for ground and air vehicles, the chief prospect of a further major improvement appears to be in degree of freedom from knock. Freedom from knock depends upon the chemical constitution of the components of the fuel. The use of Diesel fuels in automotive vehicles is still too new to point future directions with complete clarity, but the principal improvement will probably be in ignition quality. In lubrication, some of the major needs are better and more stable lubricants and better means of telling whether an oil is good enough for any particular service.

Lubricating Oil Addition Agents, O. M. REIFF, *Ind. & Eng. Chem.* **33** (1941) pp. 351-7.

In the use of addition agents as a means of improving the lubricating qualities and oxidation stability of lubricating oil the practice has been to add a separate ingredient for each of the improvements to be effected. The purpose of the author's paper is to describe the application of certain phenolic compounds and their metal derivatives as lubricating oil addition agents. Some of them have multifunctional value in the sense that the lubricating oil may be improved in more than one important property by the addition of a single compound. Some of the compounds exert a pour-point depressant action, improved viscosity index, and confer antioxidant value to the lubricating oils. The effectiveness of the multifunctional addition agents is improved by the introduction of metal substituents, particularly in respect to antioxidant value. Attention is directed to the importance of the type of solubilizing radical as well as the kind of metal substituent in the formation of metal salt addition agents having antioxidant value.

Oxidation of Petroleum Lubricants, L. L. DAVIS, B. H. LINCOLN, G. D. BYRKIT AND W. A. JONES, *Ind. & Eng. Chem.* **33** (1941) pp. 339-50.

One of the most active problems being studied in petroleum and mechanical laboratories is the oxidation of lubricants in service and the effect of the oxidation products on the equipment lubricated. The study of oxidation of lubricants can be divided logically into three subjects: (1) the oxidation of the oil and the factors that determine its rate; (2) the quantity and kind of oxidation products; and (3) the effect of the products of oxidation on the engine or equipment. The oxidation of petroleum lubricants is an auto-

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About 99% of valve wear comes on the seat rings or discs. When they're worn, the rest of the valve is usually as good as new.

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Fairbanks RENEWABLE Valves eliminate this big waste. If a leak develops, you simply remove the worn seat ring or disc and slip in a new one. The whole operation takes only a jiffy. You don't even have to remove the valve from the pipe line or disturb the covering.

And the cost is only *cents* compared with *dollars* for a whole new valve. In addition, this saves the time, trouble and expense of removing non-renewable types from the pipe line and does away with costly shut-downs.

Why not stop this deplorable waste now by replacing your worn valves with Fairbanks "Renewables"!

Write for catalog No. 21 and name of our nearest distributor.

Fig. 0302—150 lbs. steam pressure

THE FAIRBANKS COMPANY

Valves, Dart Unions, Hand Trucks and Wheelbarrows

20 East 4th St., New York, N. Y.

Boston, Mass.; Pittsburgh, Pa.—Distributors in Principal Cities

Factories: Binghamton, N. Y.; Rome, Ga.

Fairbanks Renewable Valves

catalytic reaction, the initial phases of which have been investigated by an oxygen absorption test. Effects of crude source, methods of refining, accelerators, and inhibitors may be studied in this manner. Two types of inhibitors are distinguished—true antioxidants and precipitants. The latter only are effective against metallic accelerators. Oxidation products are proximately separable by solvents and adsorption methods. Ultimate analyses of insolubles and oil-soluble resins, stepwise separated from the oil used, show decreasing oxygen contents. Practical engine tests must finally determine the choice of inhibitors. Such tests emphasize the advantages of certain sulfur-bearing derivatives over simple antioxidants. Sulfur-bearing esters of the "Methyl-S-linoleate" type have all inhibiting characteristics to a marked degree.

Recovery of Asphalts and Liquid Asphaltic Road Materials from Solution, T. F. FORD AND K. G. ARABIAN, *Ind. & Eng. Chem.,* Anal. Ed. **13** (1941) pp. 140-3.

In evaluating the service behavior of asphalts used for paving composition, test samples must be recovered from the mixtures with the mineral aggregates. Usually the binder is extracted with a solvent and the solvent subsequently removed from the extract by distillation. The authors describe a method of fractionation and carbox dioxide sweeping for the separation of carbon disulfide or benzene from penetration asphalts. The method requires a somewhat more complicated apparatus than the Abson method, which is in wide use, but the results are more reliable, particularly for cracked asphalts that may contain light oils, or for asphalts of unknown origin. The apparatus is nearly identical with one used by Siegmann for the recovery of liquid road materials. It can be used for penetration asphalts and also for liquid asphalts following Siegmann's procedure. Several tables of data are given showing the results of the application of the method.

Asphalt and Its Constituents. Oxidation at Service Temperatures, R. R. THURSTON AND E. C. KNOWLES, *Ind. & Eng. Chem.* **33** (1941) pp. 320-4.

Three types of petroleum residuals were studied. These were: Mexican asphalt of 257 penetration and 77° F. obtained by the steam reduction of heavy Mexican crude oil; (2) a residuum of 76-second Saybolt Furol viscosity at 210° F. obtained by the atmospheric and vacuum shell still reduction of Gulf Coastal crude oil; and (3) a residuum of 407-second Saybolt Furol viscosity at 210° F. from the reduction of a mid-continent crude oil in a vacuum tube still. Each was separated into 5 components by precipitating the asphaltenes with pentane, the resin with propane, the wax with methyl ethyl ketone benzene solution, and the paraffinic and naphthenic oil components by extraction of the oil with acetone. Extensive tests on these components indicated that they represented characteristic fractions of an asphalt. Under weathering conditions asphalt surfaces undergo oxidation. This photooxidation of asphalt and its components was studied by exposing samples in oxygen-filled sealed Pyrex containers under a sun lamp at a temperature of approximately 170° F. All of the components, i.e., asphaltenes, resins, naphthenic oil, paraffinic oil, and wax, absorbed oxygen. The resin and naphthene oil were the most readily oxidized. Part of the oxygen absorbed was eliminated as water and carbon dioxide. All residues showed increases in weight. The method as described is applicable to the study of paving and roofing asphalts.

Higher Federal Taxes Proposed

An increase of one cent per gallon in the federal tax on gasoline, bringing it to 2½ cents per gallon, featured the schedule of new and increased taxes through which the Treasury plans to raise additional revenue of $3,600,000,000 a year, submitted to the House Ways and Means Committee April 24.

As a result of the increase of ½ cent per gallon made in the 1940 revenue act, the treasury this year will receive additional revenue of something over $125,000,000. Total collections for the fiscal year ending June 30, next, will be in the neighborhood of $335,000,000, it is indicated by the receipts for the first nine months, compared with $226,000,000 for the last fiscal year.

With the additional cent a gallon, it is estimated that collections for the coming fiscal year will run very close to $600,000,000.

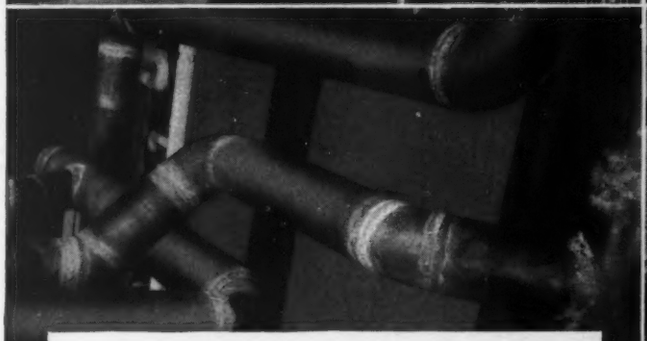
HOW TUBE-TURNS FILL 4 TIMELY PIPING NEEDS!

1 FAST INSTALLATION

Tube-Turns permit easier alignment and faster, better welding *thus speeding up today's production schedules.*

2 GREATER SAFETY

Tube-Turns' exclusive process and features, plus welding of joints, insure *greatest possible strength and safety.*



3 REQUIRE LESS SPACE

Tube-Turn elbows and returns save space, as they can be cut to any angle yet keep uniform wall thickness.

4 TROUBLE-FREE

Tube-Turn welded joints are *permanently leakproof,* and virtually *eliminate upkeep costs and delays.*

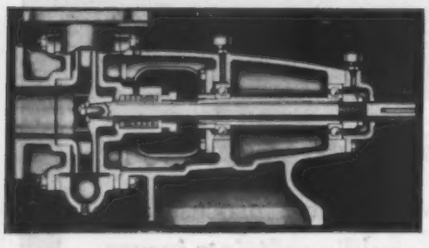
TUBE-TURNS, Inc., Louisville, Ky. • *Branches:* New York, Chicago, Philadelphia, Pittsburgh, Los Angeles • Distributors everywhere

New Equipment for the Modern Plant

Centrifugal Pump

MICRO-WESTCO, INC.

A line of side-suction centrifugal pumps in flexible-coupling drive and motor-enclosed styles has been announced by Micro-Westco, Inc., Bettendorf, Iowa. The flexible-coupling-drive models are available in sizes 1¼ to 6 inches, and those with motor from 1¼ to 4 inches.



Mictro-Westco's side-suction centrifugal pump, flexible coupling drive model

The pumps are of close-grained cast iron with torpedo type frame designed to absorb operating strain and to guard against misalignment. The suction cover is rib-reinforced to withstand distortion. Oversize ball bearings on the flexible coupling drive models are completely enclosed and have flush-type lubrication. The steel shaft can be removed, and the cover has a packing box separate from volute body.

Enclosed or semi-open impellers are hydraulically and mechanically balanced to provide quiet operation. Enclosed style impeller, recommended for handling clear liquids, has triple-faced wearing surface and can be adjusted to compensate for wear. Semi-open impellers for liquids containing foreign materials in suspension have a tapered fit to provide positive centering on shaft.

The volute shell is designed to provide a smooth, streamlined channel flow to minimize turbulance within the pump and reduce erosion. Discharge can be installed in four positions without reducing accessibility of the stuffing box.

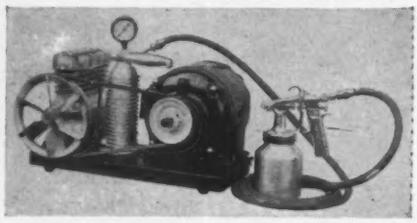
Special metals can be furnished for handling corrosive or abrasive liquids.

Compressor

THE CAMPBELL-HAUSFELD COMPANY

A line of 2- and 4-cylinder air-cooled compressors for pressures to 100 pounds and displacement in a range between 2.6 and 5.2 feet per minute, has been announced by The Campbell-Hausfeld Company, 241 Railroad Avenue, Harrison, Ohio.

The compressors employ a fan-equipped driving pulley, and are connected by V-belt to a motor or gasoline engine. An air chamber with filter and drain cock is provided to remove water and oil. Crankshaft is forged, with case-hardened piston pins. Pistons are 1⅜-inch diameter, and travel through a 1⅝-inch stroke. Drive is powered by a ¼- to ½-horsepower electric motor, or by a 2/3-horsepower Briggs & Stratton gasoline engine.



Campbell-Hausfeld compressor shown in assembly with spray painting equipment

Weight Control Valve

VOLUMETER COMPANY

An automatic valve for filling drums to a predetermined net weight has been announced by Volumeter Company, Wilbury Place, Buffalo, New York.

Volumeter's Weight Control Valve

Electrically controled, the valve may be attached to any beam scale for filling containers from five gallons up. It operates from a light socket, and is designed to be unaffected by air, vapors, sediment or scale in the pipe line carrying the liquid.

Refrigeration

FRICK COMPANY

A line of refrigerating machines for use with Freon-12 and designed for process applications, designated Eclipse, has been announced by Frick Company, Waynesboro, Pennsylvania. The machines are offered in three sizes, and capacities range up to 60 tons in a single unit.

Features include force-feed lubrication from a submerged oil pump, large oil screen, combination capacity control and automatic unloader, and outside type seal at the shaft. Compressors operate at speeds to 900 revolutions a minute. Standard drive is through V-belt, but engine-type squirrel-cage motors are installed directly on the shaft when desired. The machines may be operated in parallel, using an oil-pressure equalizing system. They are offered in 3-, 4- and 6-cylinder models.

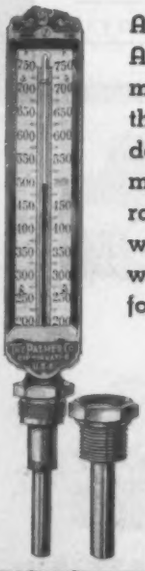
Safety Valve

THE INFERNO COMPANY

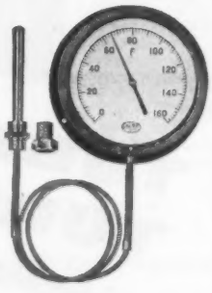
A line of 2-inch safety valves in five styles for steam to 350 pounds, 450° F., or for oil, water or gas to 1000 pounds, designated high-capacity type, has been announced by The Inferno Company, Shreveport.

The valves employ stainless-steel stems, malleable-iron bodies with tested tensile strength from 55,000 to 60,000 pounds, and nickel-alloy valves and

ESSENTIAL *To National Defense . . . Are* **FINE TEMPERATURE INSTRUMENTS**



As important as proper food for the ARMY are good Temperature Instruments that help to build and maintain the equipment necessary in modern defense work . . . And PALMER Thermometers will stand the tests for accuracy because they have been made with A-1 materials, by highly skilled workmen and are thoroughly annealed for lasting accuracy.



(Write for new editions: No. 200-F and No. 300-D Catalogs)

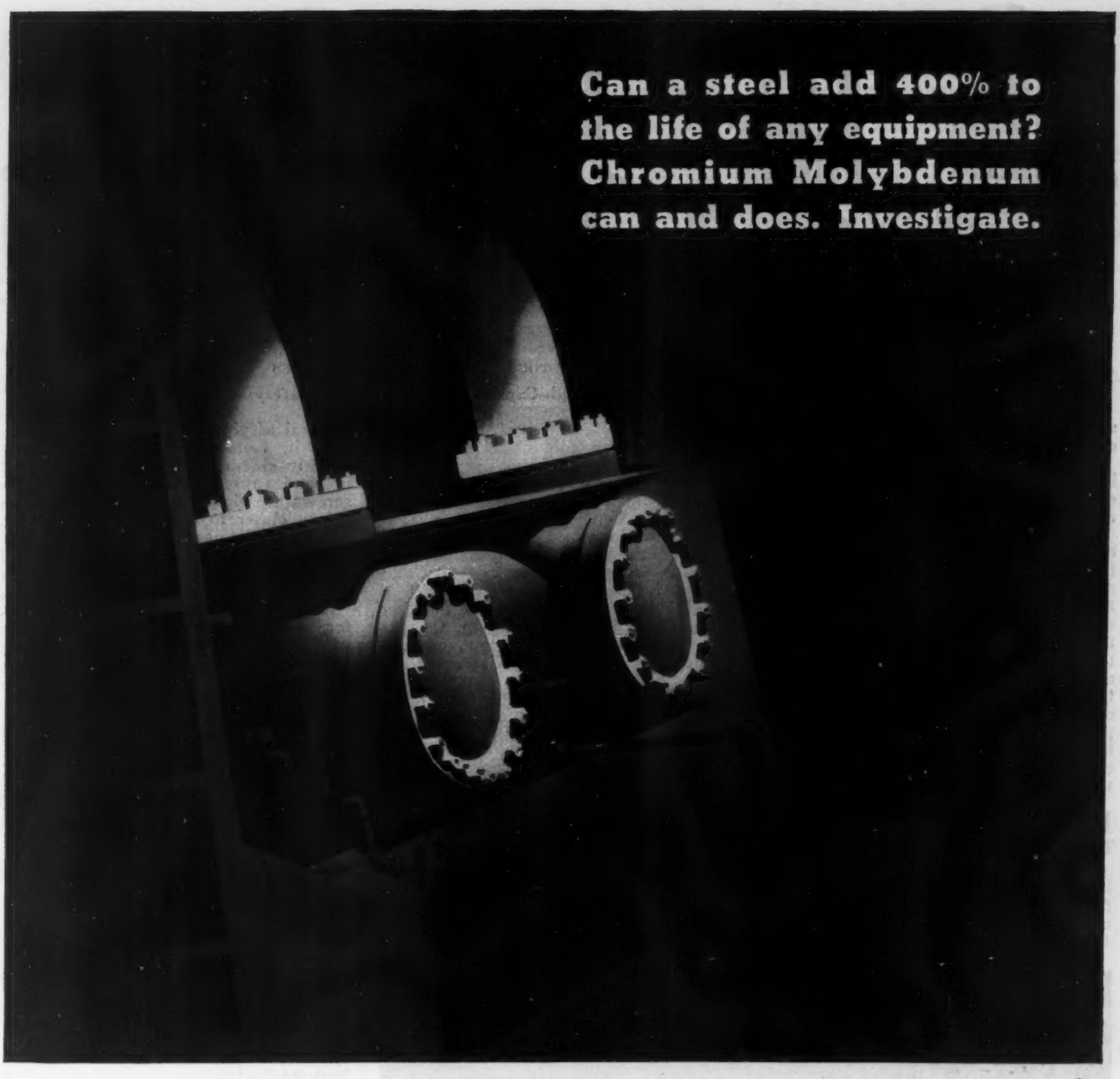
See detailed data, page 261, 1940 Refinery Catalog

THE PALMER CO.

Manufacturers: Indicating, Laboratory, Dial and Recording Thermometers

2513 NORWOOD AVE., CINCINNATI NORWOOD, OHIO

Canadian plant: King & George Sts., Toronto



How well the surge blocks stand up to their job has an important bearing on hot oil pumping costs. And cast 4.6% Chromium-Molybdenum Steel has proved that it does lengthen block life, because it not only retains its strength after repeated heating and cooling, but has adequate corrosion resistance.

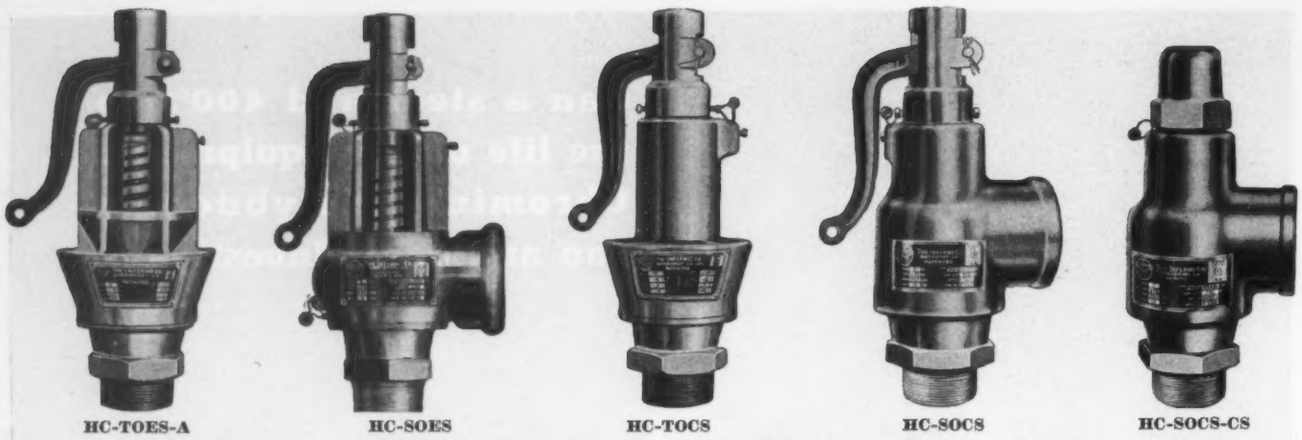
In one refinery, for example, where high sulphur-content oil is pumped, changing to Chromium-Molybdenum steel more than quadrupled surge block life.

Complete data on Molybdenum steels especially suitable for refinery equipment is contained in Sections 8 and 9 of our technical book, "Molybdenum in Steel". These sections, or the complete book, will be sent you free on request.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • CALCIUM MOLYBDATE

Climax Molybdenum Company
500 Fifth Avenue • New York City

MOLY



Five Sizes of The Inferno Company's High-Capacity Type Two-Inch Safety Valves

seats. Springs are chrome-Vandadium-cadmium plated.

The valves are set for the minimum blow-down designated by the ASME code. A lever and pull cord is provided to encourge frequent testing.

Type HC-TOES-A has a top outlet exposed spring and is designed to diffuse steam upward but away from the spring; type HC-SOES has a side outlet exposed spring and is designed with the spring exposed for inspection and to eliminate all back pressure from the top of the valve; type HC-TOCS has a top outlet with the spring enclosed; type HC-SOCS has a side outlet and is designed for use where steam must be piped away, and type HC-SOCS-CS has a side outlet with spring enclosed, capped and sealed, and is designed for use as a relief valve.

Floor Patch

TRUSCON LABORATORIES, INC.

A cementitious material for patching holes, ruts and worn places in cement floors, designated Floor-Patch, has been announced by Truscon Laboratories, Inc., Detroit.

In application, unsound concrete is removed with a cold chisel or similar tool; oil, grease or asphalt are removed by a wire brush, and the area is scrubbed out with water. The compound is mixed with water to a consistency of heavy mortar, and a small amount placed in the area to be patched. This is thinned down with water and scrubbed into the entire area with a stiff-bristle broom to provide a bonding coat, after which the entire area is filled with the mixed compound and leveled and finished with a steel trowel.

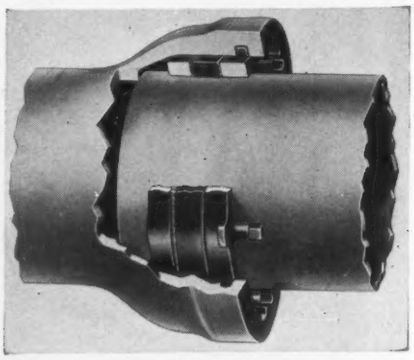
Pipe Joint

DRESSER MANUFACTURING COMPANY

A mechanical joint for use with cast-iron pipe, described as single-gasketed, self-contained, flexible and corrosion-proof, and designated Style 85 Bellmaster, has been announced by Dresser Manufacturing Company, 41 Fisher Avenue, Bradford, Pennsylvania. It consists of an inner ring, armored gasket, outer ring and a set of capscrews, all factory assembled into a single unit.

To install, the joint is inserted in the bell end of pipe prepared to accommodate it, locked in place by twisting slightly clockwise, spigot end "stabbed in" and capscrews tightened. As capscrews are tightened, the inner ring is drawn closer to the locked outer ring, expanding the gasket against the outside of the spigot and against the inside of the bell to make a tight seal. Only a small ratchet wrench is needed to install.

The joint is rated, in smaller sizes, for deflecting through an arc of as much as 18 degrees without impairing tightness or efficiency. The resilient gasket permits deflection in any direction, as well as longitudinal movement caused by expansion and contraction. It is enclosed by the bell of the pipe in which it is inserted.



Dresser Style 85 Bellmaster Joint

Style 85 Bellmaster is now available in the following pipe sizes, with other sizes to be available soon: 4-, 6-, 8-, 10-, 12- and 16-inch.

Filter

S. G. FRANTZ COMPANY

A line of permanent magnet filters for lube oil purification, designated Series PQ, has been announced by S. G. Frantz Company, 161 Grand Street, New York.

Located in the oil pipe line to become a part of the circulating lube oil system, the filter consists essentially of a stock of magnetized screens enclosed in a cylindrical casing through which the oil flows. The screens have triangular mesh openings of about ⅛-inch. The filter is designed to catch iron and steel particles as fine as one micron, or 1/25,000-inch diameter.

Offered in two sizes, Model P3Q, has a 1-inch pipe connection size; capacity of 20 gallons per minute; is 8 inches

MECO
COMPANION FLANGES
Pictured above is a small portion of our stocks of low hub forged steel companion flanges. Available in sizes ¾" to 24" . . . 150 lb. to 2500 lb. American Standard . . . for immediate delivery.
MAINTENANCE
ENGINEERING CORPORATION
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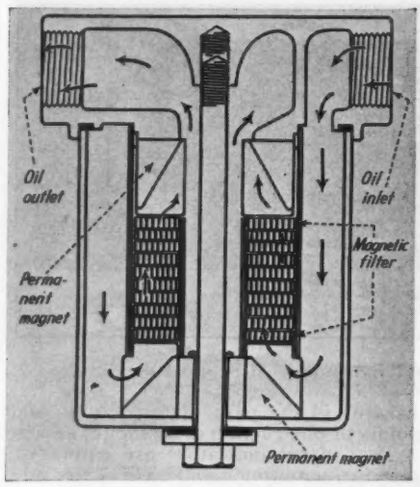


Frantz Company's PQ Filter

high with 5¾-inch length over pipe connections and 4½-inch diameter shell. It weighs 12 pounds, and operates at a working pressure of 100 pounds per square inch. Model P2Q has a ¾-inch pipe connection size; capacity of 10 gallons per minute; is 5¾ inches high with 4⅜-inch length over pipe connections and 3¼-inch diameter shell. It weighs 6 pounds, and, like Model P3Q, operates at 100 pounds working pressure.

The filters are designed with no moving parts, and with all parts accessible for quick cleaning.

Metallizing Gun

METALLIZING ENGINEERING CORPORATION

A metallizing gun, designated Type 2E and designed with a controlled power unit to give uniform and steady wire feed for production service, eliminating need for gear changes, has been announced by Metallizing Engineering Corporation, 21-07 41 Street, Long Island City, New York. A universal gas head allows use of acetylene, propane, hydrogen, natural or manufactured gas with balanced pressures.

The gun is used for restoration of worn machine parts, including bearing surfaces, rolls, shafts, pump rods, press fits, and for repairing defects in castings with carbon steels, stainless steels, bronze, brass, monel metal, nickel and other metals. It may also be used for application of corrosion resistant coatings of zinc, aluminum, lead, tin and other metals to all types of equipment.

In operation, wire is automatically fed into the gun at an adjustable speed, where it is melted by means of concentrated flame, atomized by compressed air and sprayed on any base material. The gun may be used as a hand tool for coating large structures, or as a lathe tool for building up worn shafts, rolls or plungers.

The controlled power unit controls wire speed by means of a governor, operating on the power absorption principle to allow full power input at all times and eliminate speed fluctuations under varying loads and the necessity for changing gears in the gun.

The tool weighs 4¾ pounds. Gear case is of aluminum alloy, completely sealed. Two-piece case construction combined with removable drive gear and roll are designed to make the unit easy to clean and inspect. Ball bearings are used throughout, and bearing housings constructed of brass are mounted in the case. Ports affecting alignment are assembled with dowel pins or cylindrical fits, and alignment is not dependent upon threaded sections. Worms are cut integral with their shafts, and are ground after hardening. Wire nozzles are of bronze with a hardened lining designed not to fuse or stick to the metal being sprayed. Gas head is made of a dense pressure-tight bronze, separated completely from the case assembly to eliminate danger of in-

Metco Metallizing Gun

GET MAXIMUM
Treating and Blending Flexibility
AT LOWER FIRST COST

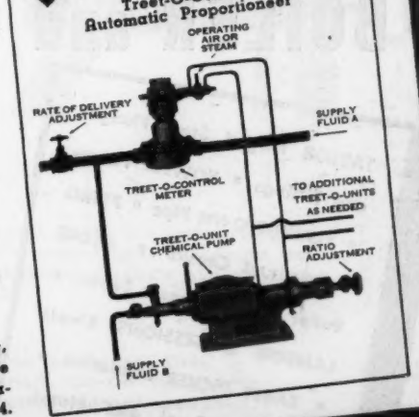
EXAMPLE:
Engineers have been accustomed to using two or more motor driven proportioning pumps (Fig. 1) with manual stroke adjustment for blending and treating operations.

Improved results and simplification of layout will be obtained in most cases by using the Treet-O-Control, AUTOMATIC Proportioneer (Fig. 2).

Treet-O-Control combines any number of fluids through the use of a Treet-O-Unit pump for each fluid, in combination with a master meter.

FIG. 1
Motor Driven Proportioning Pump

FIG. 2.
Treet-O-Control Automatic Proportioneer



Treet-O-Control gives you . . .
- Centralized control.
- Lower first cost.
- No electric motors—hence, fully explosion-proof.
- Ratio adjustment automatically maintained regardless of demand.
- Wider capacity range.
- Operates on steam, gas, or air.

Send us your treating, blending, and proportioning problems. We will make specific recommendations. Ask for Bulletin SM 124.

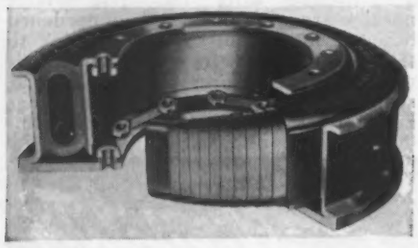
% PROPORTIONEERS, INC. %
31 CODDING STREET · PROVIDENCE, R. I.

flammable gases collecting in the case. Parts are completely interchangeable, and may be assembled without adjustments.

Flexible Coupling

THE FALK CORPORATION

A flexible coupling, designated Airflex and designed for connecting diesel, oil, gasoline or gas engines to any type of driven machinery, has been announced by The Falk Corporation, Milwaukee.



Falk Corporation's Flexible Coupling

It consists of a resilient rubber gland lined with a premoulded, prevulcanized cylindrical section treated to prevent air loss. The cylindrical lining is covered with multiple alternating layers of tough fabric and live rubber. The entire gland is bonded to rugged steel inner and outer rims. The gland is inflated to proper pressure through a Schrader valve which will take any hand pump fitting or air nozzle. A rubber covered metal cap is designed to prevent foreign material from entering the valve.

Degree of elasticity in the coupling can be varied by changing the air pressure, frequently eliminating the necessity for adjusting the setting of the connected units, or making changes in shaft diameters and lengths, or in the flywheel, to alter the torsional characteristics of the drive system.

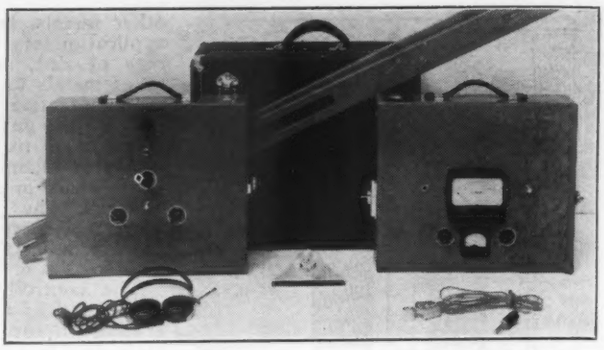
The coupling is made in six standard types. Type AR, with both hubs external, is the basic construction and is recommended for new installations where a gap between shaft ends equivalent to the width of the coupling gland can be provided. Type AR, with one hub inverted, is a modification of the basic standard and is intended for use on existing applications where the gap between shaft ends is small, or new installations where available space is very restricted. Type FM, designed particularly for equipment having flywheel on driving or driven shaft, allows gland to be bolted directly to flywheel, eliminating the stub shaft and saving space. Type AR, with thrust unit, is intended for marine propulsion applications and others where it is desired to transmit thrust through the coupling to an adjacent thrust bearing. Type XR, high-speed type, is for applications where speed is beyond the allowable for the basic AR type. A sixth type, disconnecting coupling, is for dual drives and other requirements where a quick-disconnecting coupling is required.

Pipe Finder

FISHER RESEARCH LABORATORY

A pipe finder employing conductive, inductive and radio-balance means of detection, designated M-Scope Model 1941, has been announced by Fisher Research Laboratory, 1961 University Avenue, Palo Alto, California.

The equipment is designed to locate position of buried pipe lines or metallic conductors, pipe bends, dead ends, valves, covered manholes, drip boxes, cast-iron bells, insulated joints, stubs or services, the center of a buried pipe or metallic conductor, depth of a pipe line or metallic conductor, unknown metallic hazards in the path of excavators, and points of obstruction in a plugged sewer.



Fisher Research Laboratory's M-Scope Pipe Finder

Two visual indicators are employed, one for centering pipes and cables and determining their depth, and the other for tracing pipes. The instrument does not have to be grounded, and power output can be regulated in five steps. It is rated to trace pipes or cables for 1000 feet.

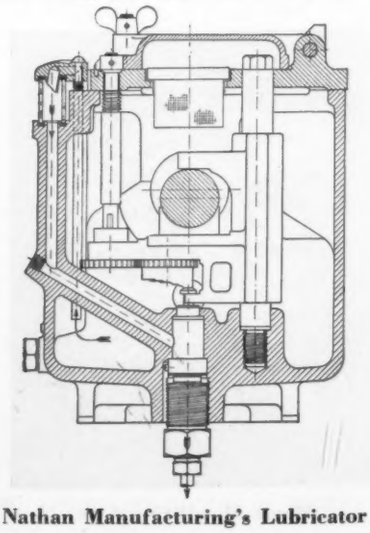
Non conductive lines, such as sewer, may be traced by pushing a steel tape or wire through the line and connecting it to the conductive terminal on the transmitter housing. The equipment consists of a transmitter, receiver, earphones, spirit level and conductive wire with clips. A set of handles is included for operating the instrument when it is necessary to use it coupled.

Lubricator

NATHAN MANUFACTURING COMPANY

A mechanical lubricator designed for pressures up to 20,000 pounds, designated Type HD, has been announced by Nathan Manufacturing Company, 250 Park Avenue, New York.

The lubricator employs four independent pumping units in the oil reservoir, one for each feed outlet. The pump-units consists of a packless piston fitted oil-tightly into a cylinder. They are designed to draw oil from the reservoir through sight-feed glasses in drops by a vacuum created during the suction stroke. Each pumping unit is actuated by a yoke which, in turn, receives its movement from an eccentric shaft of liberal proportions. The oil can be regulated individually for each feed by ad-



Nathan Manufacturing's Lubricator

for GLOBE

BOILER and CONDENSER TUBES

call

CORBETT-WALLACE

We carry large stocks in Houston of all sizes of: Globe Seamless Steel Boiler tubes, low carbon or alloy seamless mechanical tubing and Globe condenser tubes.

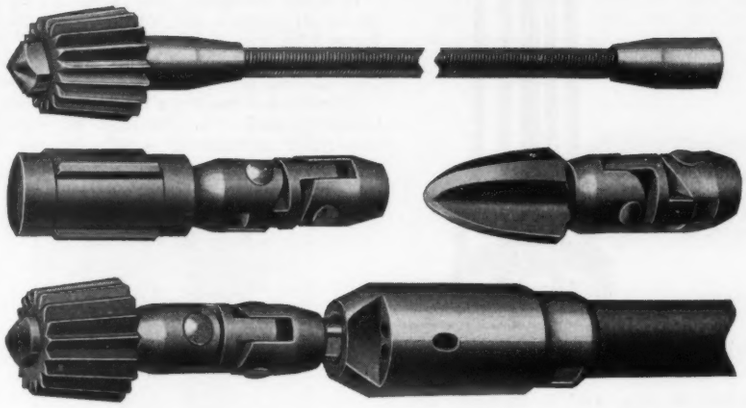
TAYLOR Forged Steel Flanges and Fittings • POWELL Valves • YOUNGSTOWN Pipe • PETRO Unions and Checks • GLOBE Boiler and Condenser Tubes • LAMSON & SESSIONS Rivets • EAGLE PICHER Insulation • STEEL, Structural and Plates.

CORBETT-WALLACE CORPORATION

Quality Products Plus Engineering Assistance

SAWYER AND WINTER STREETS • HOUSTON • PHONE CAPITOL 5327

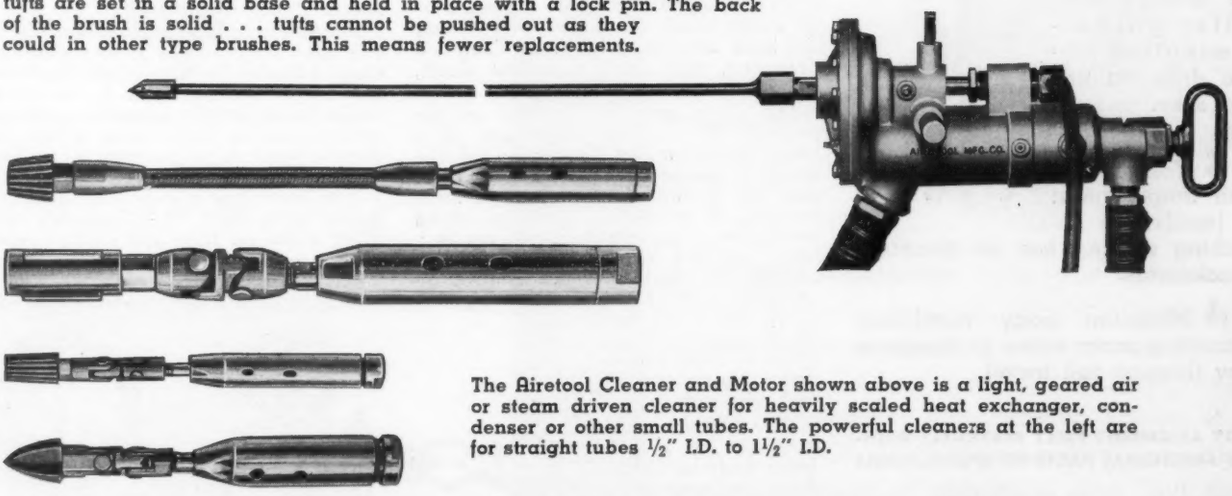
Airetool LINE OF SMALL TUBE CLEANERS



For maximum efficiency, all tubes should be thoroughly cleaned. In one actual case, thorough cleaning of heat exchanger tubes provided an increase of 20%, in heat transfer and 10% increased throughput. Shown on this page are a variety of small tube cleaners made by Airetool. Those at the left are particularly effective in tubes of very short radius bends. Cutter heads, expanding blade heads, drill heads and brushes are available for all size tubes.

THE LATEST IMPROVEMENT

Shown above is an Airetool Cleaner with expanding brush type head. The brush segment (shown in the circle) is a new Airetool development. Wire tufts are set in a solid base and held in place with a lock pin. The back of the brush is solid . . . tufts cannot be pushed out as they could in other type brushes. This means fewer replacements.



The Airetool Cleaner and Motor shown above is a light, geared air or steam driven cleaner for heavily scaled heat exchanger, condenser or other small tubes. The powerful cleaners at the left are for straight tubes 1/2" I.D. to 1 1/2" I.D.

Whatever your tube cleaning problem, Airetool has an efficient cleaner for the job. Sizes, 1/2" to 20" I.D. Airetool also makes Tube Expanders, Tube Jigs, Flycutters, Cut-Off Tools, Safe Catalyst Cleaning System; Calipers, Tube Gauges, Tool Trucks and other refinery specialties.

Write for information

THE AIRETOOL MANUFACTURING CO.

SPRINGFIELD, OHIO

REPRESENTATIVES IN PRINCIPAL CITIES

NEW YORK OFFICE, 50 CHURCH ST.

justing the effective stroke of the pumping pistons.

The lubricator can be provided with either a ratchet drive for reciprocating movement, or with a rotary drive for connection to a motor. It is furnished with from one to four feeds, each rated to operate against a pressure of 20,000 pounds.

Mixer Guard

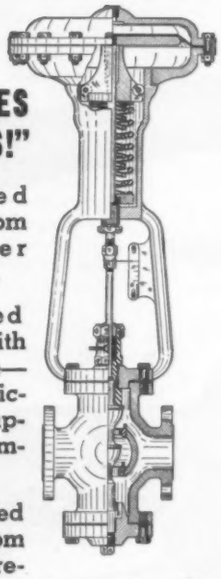
ECLIPSE AIR BRUSH COMPANY

A metal ring guard designed to act also as a stand has been announced as available on clamp-type portable air-motored agitators of Eclipse Air Brush Company, 400 Park Avenue, Newark, New Jersey.

The ring is designed to protect the propeller from contact with the mixing vessel when in use, and to provide an easy means of storage by eliminating the necessity for suspending the mixer when not in use. Four metal supports hold the ring in place and protect the shaft from getting out of alignment. Metal handles alongside the air motor, at the top of the frame, facilitate lifting the agitator from the mixing vessel.

Eclipse Mixer with Guard

NEW H-W Type 86 MOTOR VALVE



4 FEATURES THAT ARE "NEWS!"

1 Improved top and bottom guided inner valve structure.

2 Advanced top works with roller guide—eliminating friction drag on upper stem assembly.

3 Yoke styled with ample room to facilitate repacking stuffing box or mounting attachments.

4 Minimum body restriction permitting inner valve to dominate flow through full travel.

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Available in iron or steel bodies with standard code pipe flanges in any series from stock.

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New York, Chicago, Pittsburgh, Philadelphia, St. Louis, Denver; Shreveport and Lafayette, La.; Fort Worth, Houston, Corpus Christi, Longview and Odessa, Texas.

Valve for Governors

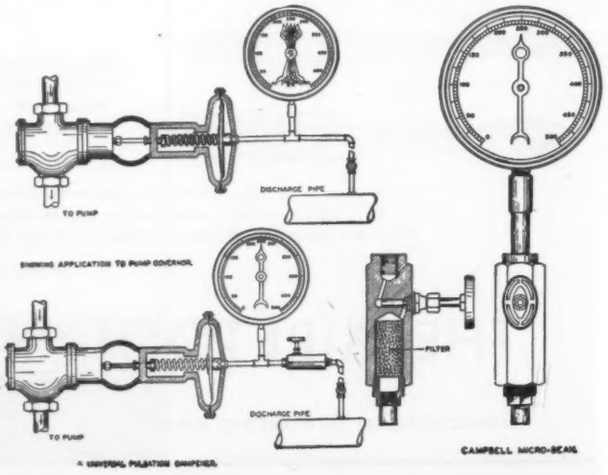
J. A. CAMPBELL COMPANY

A micro-action valve designed to dampen pulsation of boiler plant pump governors and to eliminate vibration of the gauge hand, designated Micro-Bean, has been announced by J. A. Campbell Company, 645 East Wardlow Road, Long Beach, California.

The valve may be installed on the pressure line to the diaphragm of a pump governor for protection of the pressure gauge mechanism and tube, also the spring, diaphragm and stem packing. It is also designed to afford protection to a control valve, such as a back pressure or reducing regulator, and for use with sensitive control instruments subjected to pulsating flow.

The valve will handle steam, fuel oil, gas, water or other liquids, with adjustment for each viscosity.

The Micro - Bean consists of a solid brass body in which a filter is inserted for protection from foreign matter. The valve has slight taper to provide sensitive control of the shut-off and to minimize the tendency to pinch off, under changing pressure conditions. Micrometric control of the opening is designed to enable the operator to obtain the closest approach to full shut-off down to the last 0.0003 of an inch, regardless of the line content. A solid metal body is provided to minimize the effect of body strain. A 48-to-1 taper of the valve minimizes the effect of stem and screw compression strain. The device is designed for varied purposes up to 3000 pounds pressure, and to give any degree of stabilization desired by turning a valve.

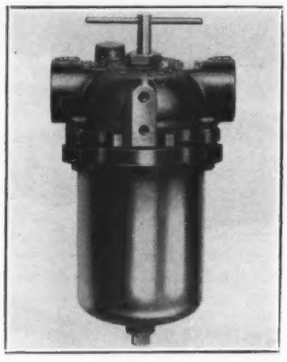


Filter

THE CUNO ENGINEERING CORPORATION

A filter designed for flows of fluids up to 30 gallons per minute, designated Type EG, has been announced by The Cuno Engineering Corporation, Meriden, Connecticut.

The device employs edge filtration, in which filtration is obtained by passing the fluid containing solids to be removed between strips of metal, separated by spacer pieces of predetermined thickness, placed edgewise to the flow to retard solids larger than the space between the strips. The strips in the filter take the form of wheel-shaped parts or discs separated from each other by spacer pieces.



Cuno Engineering's Type EG Filter

Solids which have accumulated on the cartridge are removed as they reach the cleaner blades by turning the handle of the filter. This operation is carried on while the filter is in operation, collected solids dropping to the sump where they remain until it is convenient to blow them down or otherwise remove them.

The filter has a cast iron head and drawn steel sump for 125 pounds operating pressure. Inlet and outlet connections are 1-inch standard pipe thread. The cartridge is 2¼ inches in diameter by 4 or 5 inches long, and may be ob-

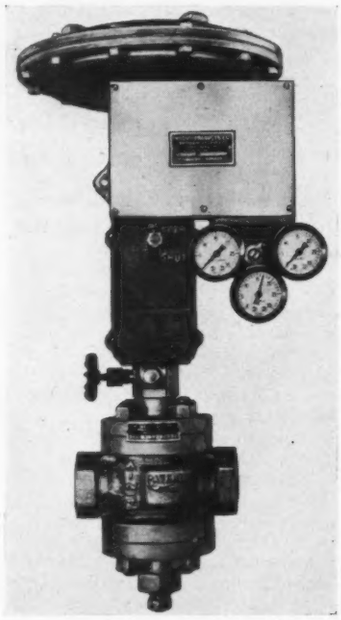
tained of steel, bronze or stainless steel. For special services, the filter is available with cast bronze head and drawn brass sump.

The filter may be mounted to a vertical surface by means of one or two mounting pads located on opposite sides of the filter head. Mounting holes are drilled and tapped when specified. The sump, which is held to the head by a clamping ring and four bolts, may be removed without breaking pipe connections. The filter is equipped with either a vent or relief valve.

Valve Positioner

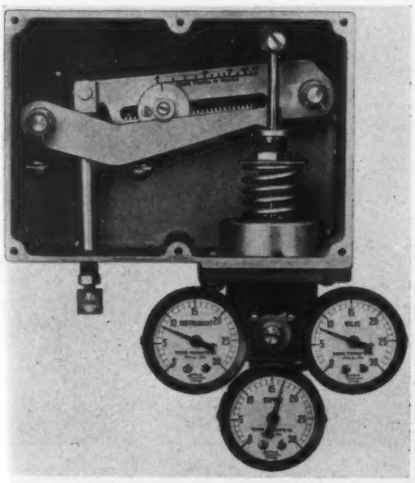
MOORE PRODUCTS COMPANY

A valve positioner for diaphragm-operated valves, providing for use of a by-pass valve as an interchangeable part of the unit, has been announced by Moore Products Company, 3629 North Lawrence Street, Philadelphia.



Moore Products' Valve Positioner

In operation, a calibrated loading spring, in addition to operating pilot bellows, acts in the same direction to take up back lash in the lever connections. Adjustments for valve strokes of from ½-inch to 2½ inches, and for setting zero, may be made without interrupting the control process. By turning the by-pass, the positioner may be completely removed without upsetting the service.



Construction of Valve Positioner

The unit is designed to always provide a linear relationship between the instrument air pressure and the actual motion of the valve. Bellows and stainless-steel pilot are a self-contained unit, made without levers that might increase friction and cause hysteresis errors.

Air consumption is less than one cubic foot of free air per minute at midstroke, and zero at either end of the valve travel as the pilot is closed at both limits.

Water Cooler

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

An explosion-proof water cooler for use in Class 1, Group D hazardous locations has been announced by Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania.

Available in three models, it has a stainless steel top, steel body and hermetically-sealed condensing unit. Capacities are 8.2, 9.8 and 18.9 gallons of water per hour cooled from 80° to 50° F. Cycling-control mechanisms and overload protective devices are enclosed to provide an explosion-proof feature, as no arcing can develop in the cooler to ignite explosive mixtures in the surrounding atmosphere.

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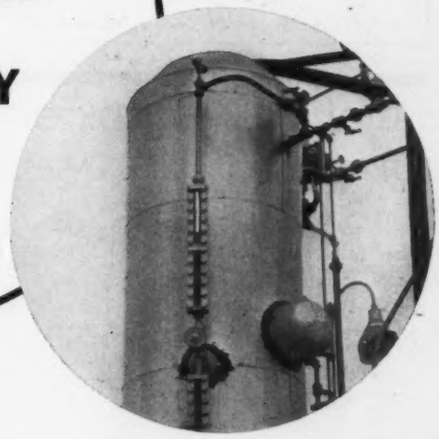

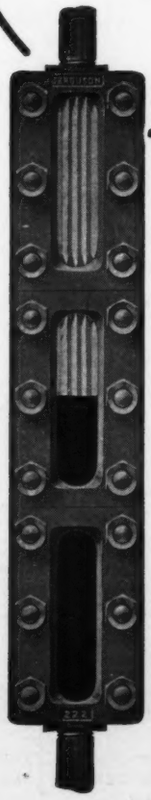

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Portable DRUM CLEANER

FAST:	Two to five minutes cleans average size drum.
EFFICIENT:	Container is left absolutely clean and free of any foreign matter.
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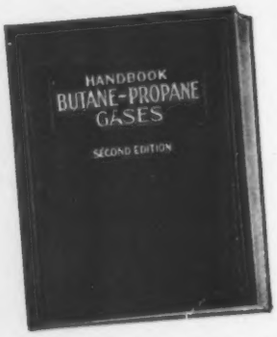

Second Edition (Revised) September, 1938

CONTENTS: Semi-Bulk Distribution: Use of Butane in Buses: Combination Propane Operated Utility Plant: Use in Internal Combustion Engines: Design and Installation of Storage: Supply from Petroleum Refineries: Engineering Data on the Lower Olefins: Domestic Appliance Testing and Utilization: Economical Comparisons with Coal, Oil, Electricity, Producer Gas, Manufactured Gas: Town Plants: Manufacture from Natural Gas: Special Uses: Volume Correction Factors: Transportation: Use with other Gases: Analysis and Testing: Properties of Mixtures: Bottled Gas Distribution: Bibliography: Central Plant Directory: Catalogue Section.

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BUSINESS NOTES

Aluminum Use by Petroleum Industry Restricted Sharply

Sharp restriction of the use of aluminum by the oil industry is provided under orders issued April 18 by the Priorities Division of the Office of Production Management, classifying industrial consumers of the metal in the order of their importance.

Indexing several hundred commodities and operations in which aluminum is used, the OPM provided that consumers of high grade aluminum next month will be limited to from 10 to 80 percent of their 1940 orders, with very few in the higher classifications, while those using low-grade metal will be given from 50 to 100 percent of their requirements. However, it was said, higher ratings will be given any of the products than provided in the list when defense orders are involved.

The index issued by the Priorities Division, which is to be the basis of aluminum shipments by producers, fabricators and secondary smelters for May, provides that all uses of the metal in petroleum refining shall be given a B4 rating, permitting the supply of 60 percent of high-grade or 90 percent of low-grade metal, but that all other uses of aluminum in the petroleum industry shall have a B8 classification, limiting supplies to 10 percent high-grade or 50 percent low-grade metal on the basis of 1940 orders.

Foxboro Company Erects Own Pittsburgh Building

The Foxboro Company, Foxboro Massachusetts, is erecting its own building at 5151 Baum Boulevard, Pittsburgh, where branch servicing department and offices will be located after May 15. The building is entirely of masonry and steel. It is completely air conditioned, and is equipped with fluorescent lighting. Bays of glass blocks take the place of windows.

Assembly and servicing departments will occupy the first floor area of 3700 square feet, and 1250 square feet of additional space will be used for offices, on the second floor.

The company opened its Pittsburgh branch in 1918, its business in the territory having been handled previously through an agency. At present, the servicing department and offices are located at separate addresses, but the new building will permit all activities of the branch to be brought together, with greater convenience for customers and for the company's personnel.

The territory served by the Pittsburgh branch includes an industrial section embracing parts of Pennsylvania, West Virginia, Ohio and Kentucky. A. H. Shafer continues as manager of the branch.

Corbett-Wallace Insulation Organized at Houston

Corbett-Wallace Insulation Corporation has been organized with headquarters at 2431 Summer Street, Houston, to distribute and contract application of Eagle-Picher's high- and low-temperature insulating materials. S. Ray Jordan has been engaged as sales manager. Officers of the company are Chas. S. Wallace, president and treasurer, and L. Keith Baldwin, vice president and secretary.

S. R. Jordan

Union Asbestos & Rubber Expands Production Capacity

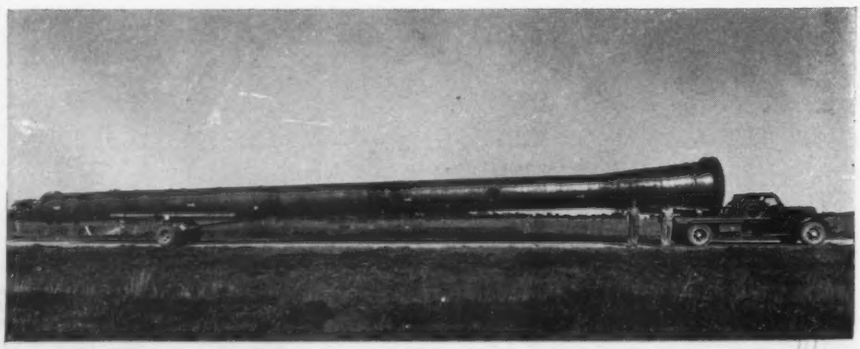
Expansion of manufacturing facilities for heat insulating materials has been announced by Union Asbestos and Rubber Company, Cicero, Illinois, with construction of a new plant now going into service in Paterson, New Jersey.

This factory will specialize in sectional insulation for temperatures up to 1200° F. for pipe up to 36-inch diameter, with thicknesses up to 5 inches and blocks and sheets up to 36x36x5 inches. The production capacity is double that of the company's Cicero plant, and provision is made for installing a duplicate manufacturing unit in the future. It is planned to handle eastern shipbuilding, oil refining, and general industrial orders from the new plant.

Stokes Increases Floor Space And Machine Tool Equipment

F. J. Stokes Machine Company has completed construction at its Tabor Road Plant in Philadelphia, of a new brick and concrete addition which increased floor space more than 50 percent.

The additional floor space, and improved plant layout it affords for straight-line production, are expected



This self-supporting stack, 100 x 4½ feet and fabricated in the Houston plant of Wyatt Metal & Boiler Works, is being delivered to a Gulf Coast refinery.

to more than double the company's manufacturing capacity. Both the new and original plant have been equipped with additional overhead traveling crane systems to facilitate materials handling, and with fluorescent lighting. New machine tools have been installed to increase production and improve accuracy in manufacture. The tool-room has been enlarged and equipped with the latest model machines, and an expanded punch and die department has been set up as a separate manufacturing division. A new boiler plant was installed to provide heat and processing steam, and a considerable amount of additional floor space was provided for office and engineering staffs.

Downingtown Manufacturing Names New York Representative

Downingtown Manufacturing Company, Foundry Division, Downingtown, Pennsylvania, has named Steel Products Sales Corporation, 52 Vanderbilt Avenue, as New York representative.

Fluorescent Recommendations Offered by W. H. Long Company

W. H. Long Company, 425 North Clark Street, Chicago, has announced a lighting engineering service being made available without obligation to proposed users of fluorescent lighting.

Recommendations are made on the basis of information submitted by the lighting user, including a sketch of space, measurements, ceiling height, outlets and wattage of each outlet.

Cincinnati Rubber Company Names Pittsburgh Distributor

The Cincinnati Rubber Company, Cincinnati, has announced appointment of John Flocker & Company, 644 Grant Street, Pittsburgh, as distributor of its line of industrial rubber products in the Pittsburgh area.

General Offices of Hercules Supply Moved to Houston

Hercules Supply Company has announced removal of its general offices from Fort Worth to 3130 Navigation Boulevard, Houston. The new mail address is Box 2595.

Supply Personals

B. J. Brugge has been named welding consultant and engineer for The Lincoln Electric Company at Washington. He will be engaged in consulting work having to do with application of arc welding in the national defense program, and will be available for such work with all governmental departments. A graduate of Purdue University, he spent two years in the company's research laboratory, served as welding superintendent for Anglo-Iranian Oil Company at Iran,

B. J. Brugge

SYMBOLS of DEFENSE

A RED KEYSTONE is the symbol worn by the men of the 28th Division, Pennsylvania National Guard, now in training at the camp just completed at Indiantown Gap, Pennsylvania. Here, under the leadership of Major General Edward Martin, they are being molded into a fighting outfit which will carry on the fine traditions of the Division.

In France during World War I the men from the Iron Division, as it was called, fought on five fronts. At Chateau Thierry, Baslieux and in the Forest of the Argonne they repeatedly formed an effective spearhead of the American advance.

During their service of 102 days in the front line they lost 14,139 men killed and wounded.

SPEARHEAD of American defense industries in their fight against corrosion is this famous "18 and 8" Columbium bearing alloy of the Lebanon Steel Foundry. With a carbon maximum of only .07, readily obtained by Lebanon's modern induction type furnaces, its Columbium content is ten times carbon. Circle L 21 is particularly suitable for use in welded assemblies because subsequent heat-treatment is not necessary to prevent corrosion at the welds. Circle L 21 meets the U. S. Navy's specific corrosion requirements, in accordance with Specification 46-S-27 Grade 1 Welding.

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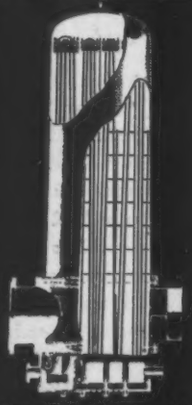
for High Pressure and Temperature.



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Persia, and for four months was welding consultant engineer for British and Scottish firms in the British Isles. Associated with The Lincoln Electric Company since 1931, he had been located in Los Angeles, and until recently was in Houston.

Frederick C. Bryan, for 30 years general traffic manager of Allis-Chalmers Manufacturing Company, died at his home in Milwaukee April 7 of a heart attack.

James P. Gillies has been engaged by Chicago Pneumatic Tool Company to assist in general sales activities.

H. L. McNally, assistant sales manager of Micro-Westco, Inc., Bettendorf, Iowa, has been named sales manager of the Westco Pump Division, succeeding Leon F. Wernentin, who was promoted to the sales department of the parent Bettendorf Company. McNally joined Micro-Westco, Inc., 16 years ago. Two engineers, C. V. Copeland and Ivor G. Morgan, have been added to the sales organization to assist McNally.

H. L. McNally

Roy S. Laird has been appointed sales manager for Ohmite Manufacturing Company, Chicago. He has been with the company five years as sales engineer. He is an electrical engineering graduate of the University of Illinois.

E. W. Heinrich has been named a divisional export manager for The Buda Company, Harvey, Illinois. He will have charge of the company's export business between Mexico and the equator. He is former divisional export manager for Caterpillar Tractor Company and Yale & Towne Manufacturing Company, and is a graduate of Yale University.

George H. Koons, division export manager for the company for many years, will have as his territory everything in South America below the equator, and will establish headquarters at Rio de Janeiro and later in Buenos Aires.

Pictured is a sales and service branch opened at Odessa, Texas, by Hercules Motors Corporation. Engineering service and complete stocks of gasoline and diesel engines and power units, and replacement parts, are available at the branch.

H. Boezinger, Los Angeles district manager for Pittsburgh Equitable Meter Company and Merco Nordstrom Valve Company, has been elected a vice president of the latter company. He is a graduate of Stanford University, and before his affiliation with Merco Nordstrom Valve Company was engaged in petroleum engineering in the San Joaquin Valley and in Southern California. He has been associated with the company since its early development, and his additional activities will cover the entire west coast.

H. Boezinger

E. H. Anchors, former district manager at Oklahoma City for Air Reduction Sales Company, has been named manager of the Birmingham district. He entered the industry 16 years ago with Commercial Acetylene Supply Company, and was southern manager of that company when it was acquired by Air Seduction Sales Company. He has since served as manager at Atlanta, and later at Oklahoma City.

E. H. Anchors

O. W. Jones electric power sales supervisor for Central Power and Light Company, Corpus Christi, Texas, on May 1 became head of the commercial

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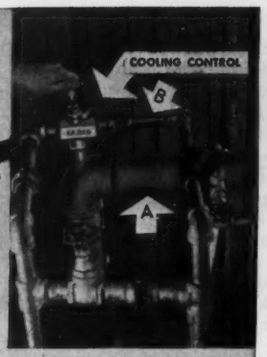

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"Now look at the ¾" pipe marked 'B'. That with the help of a Sarco TR-40 cooling control, does the trick now. It's a case where 'enough is enough' and a million gallons more of cooling water wouldn't do any better.

"We save water, save pumping, and, because the temperature is controlled to within a few degrees, we can depend upon uniform production conditions at all times." Ask for Catalog No. 197.

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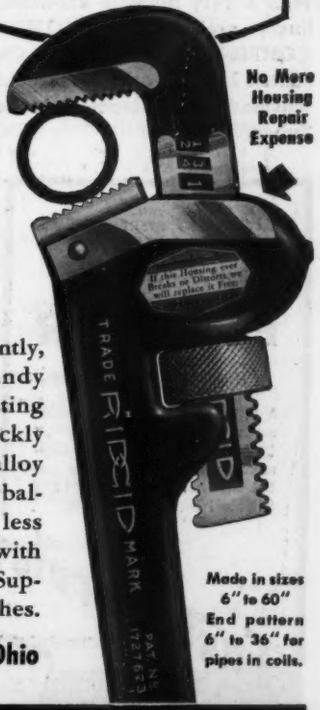
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and industrial power department of the company. For the past 14 years, he has been engaged in industrial power work for the company, and previous to that time, was connected with the Texas Power & Light Company in the same capacity. He is past president of the Petroleum Electric Power Association.

Edward W. Burbank, 52, manager of Allis-Chalmers Manufacturing Company's Dallas district office from 1922 to 1940, died April 20 after a prolonged illness which followed a stroke he had suffered in December, 1939. He started with the company as a student apprentice in 1911 after graduating from Tulane University, and served in a variety of engineering and sales capacities.

G. L. Bader has been named representative for The Midvale Company in Texas, Oklahoma, Arkansas and Louisiana, with headquarters in Houston.

Samuel S. Bruce, Jr., has been appointed sales representative for The Duff-Norton Manufacturing Company, with headquarters at the company's general offices in Pittsburgh. A graduate of Massanutten Military Academy and Franklin & Marshall College, Bruce was formerly with a contracting company.

O. A. Schilling, sales engineer in the Gulf Coast area for Mechanical Goods Division, Goodyear Tire & Rubber Company, has been named Mid-Continent district manager with headquarters at Dallas. He is succeeded in the Gulf Coast area by W. R. Burtle, formerly at Louisville. Burtle will make his headquarters at Houston.

O. A. Schilling

W. R. Burtle

Harry L. Strube, assistant chief engineer for Link-Belt Company at Philadelphia, has been named chief engineer for the company's Eastern Division, succeeding F. F. Waechter, retired. Strube will make his headquarters at Philadelphia. He started in the engineering department of the company's Pershing Road Chicago plant in 1910. Subsequently, he served as sales engineer, first at Chicago and then in Philadelphia. In 1924 he was made manager of vibrating screen sales, and became assistant chief engineer in 1934.

H. L. Strube

J. K. Beeson has been elected vice president in charge of sales for Pittsburgh Steel Company. He has been connected with the company since 1930 in a number of capacities, including assistant superintendent of the Monessen works, manager of manufacturers' product sales, assistant sales manager and assistant general manager of sales.

H. H. Brown, former assistant purchasing agent for Frick-Reid Supply Corporation, Tulsa, has been named manager of inventory and is charged with maintaining continuous control of store, warehouse and yard inventories. A. F. Stadler has been promoted to assistant purchasing agent.

Howard M. Dawson, of the Cleveland office of the Jessop Steel Company, Washington, Pennsylvania, has been transferred to the Detroit office, according to T. W. Pennington, general sales manager. D. J. Hanna is branch manager of a new Detroit warehouse and office at Woodbridge and Walker streets.

American K. A. T. Corporation Opens Philadelphia Office

American K. A. T. Corporation has announced opening of a Philadelphia office under the direction of Frank Campbell Coe in the Commonwealth Trust Building.

Ralph N. Brodie Company Moved To Larger Dallas Office

Ralph N. Brodie Company has moved into larger Dallas quarters at 2815 Canton Street. The office is under the direction of J. J. Kropp, district manager.

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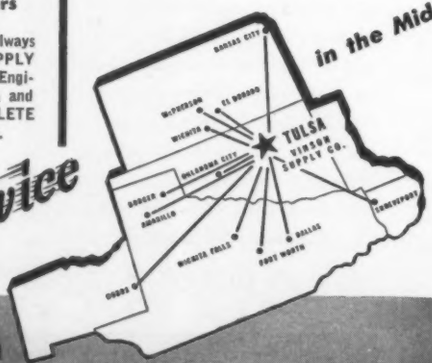

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